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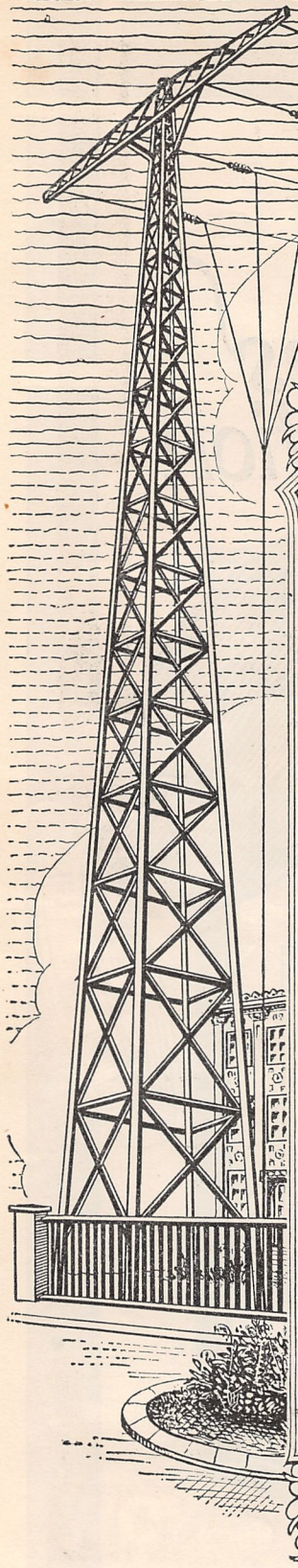

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VOLUME 7 NUMBER 7

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Automatically Controlled R.F. Amplifier and Detector Using Regeneration.
By Sylvan Harris.

This new circuit employs the principle of the Automatic Regenerator described in this issue of RADIO NEWS, a new development in radio circuits.

* * *

More About Radio Waves.
By Joseph Riley.

The discussion of how radio waves are propagated is continued, enabling the reader to coordinate all the scattered ideas he has gathered from the miscellaneous articles on transmission heretofore printed in the popular press. In this article some of the causes of dead-spots and fading will be explained.

* * *

Tracing Interference To Its Lair. By S. R. Winters.

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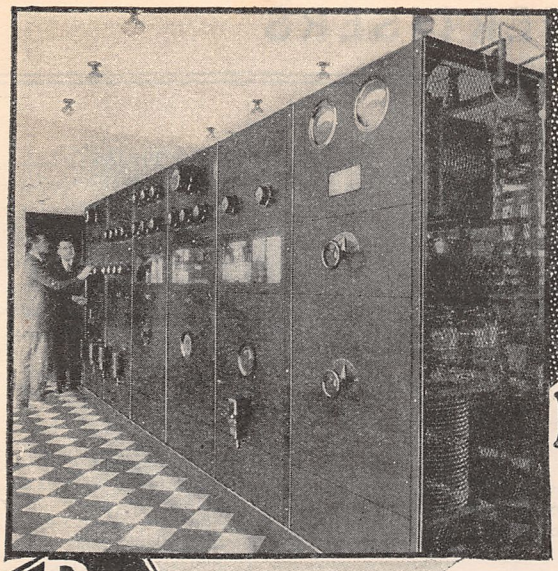

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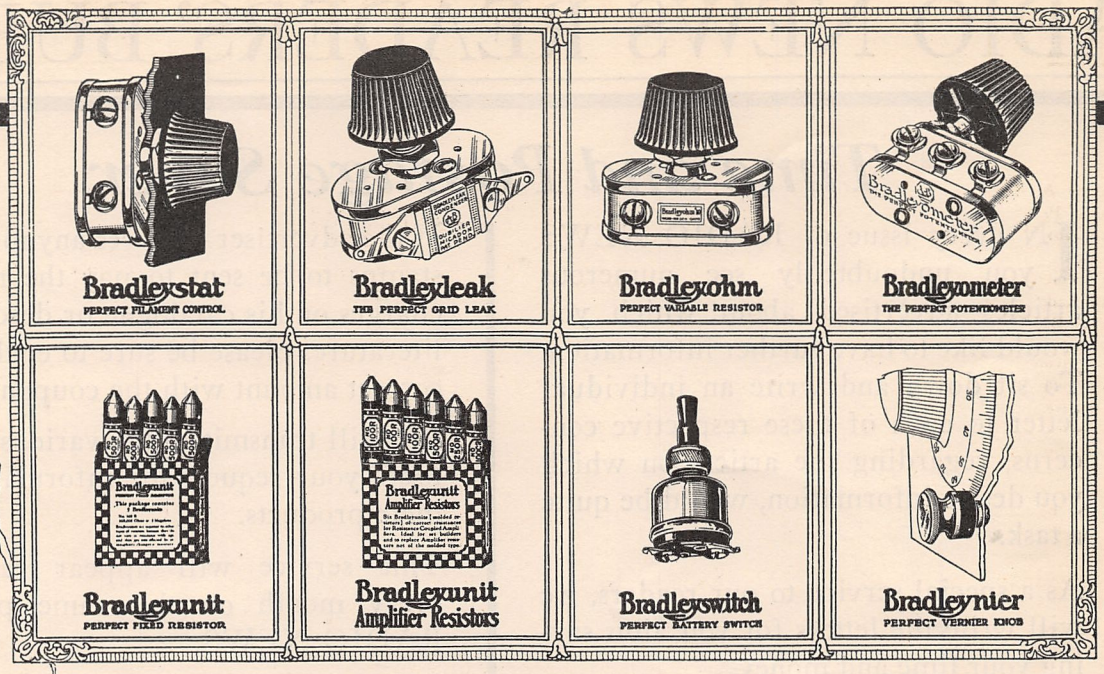

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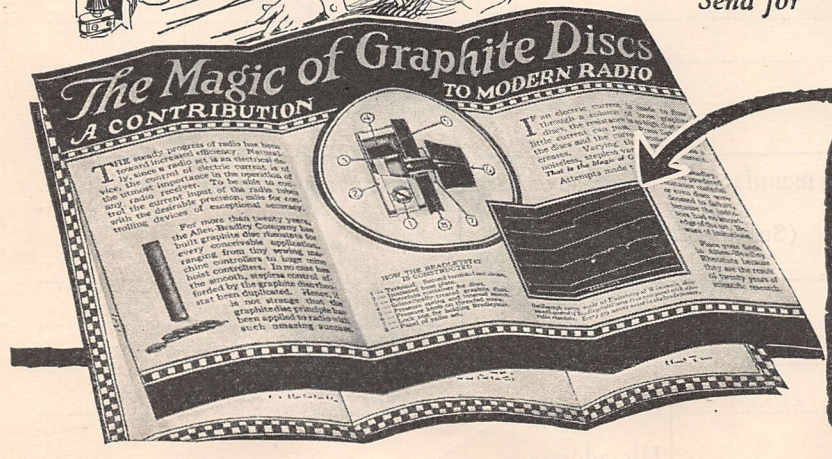

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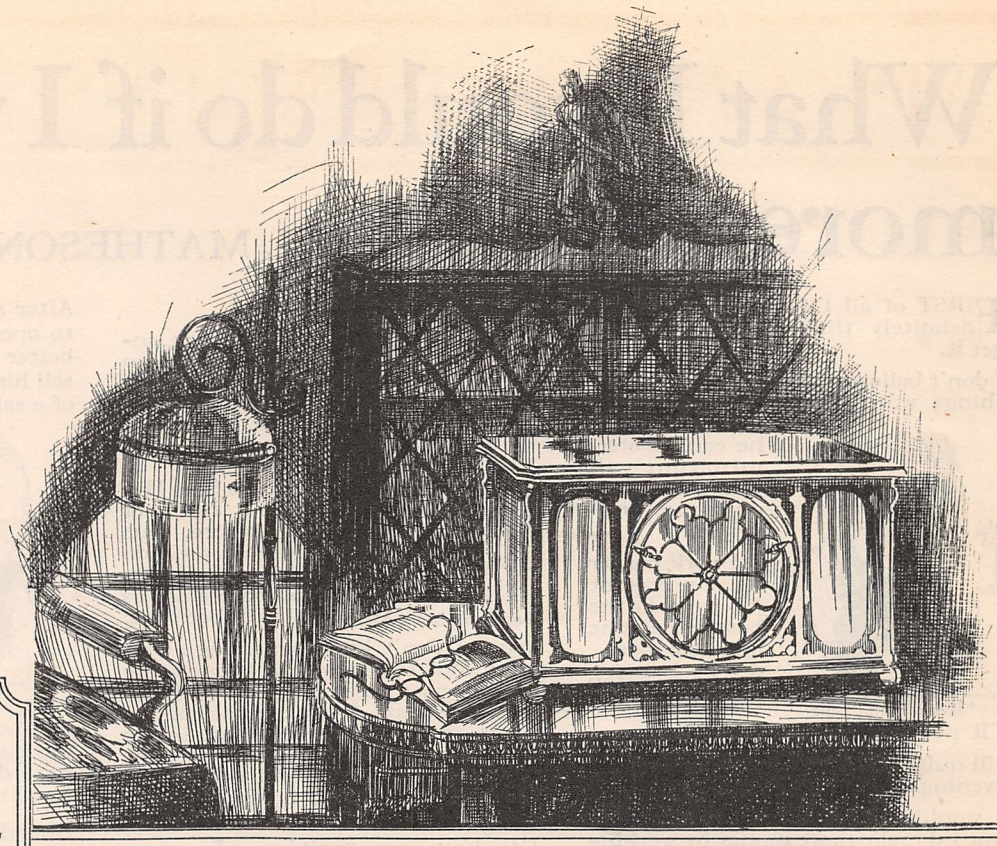

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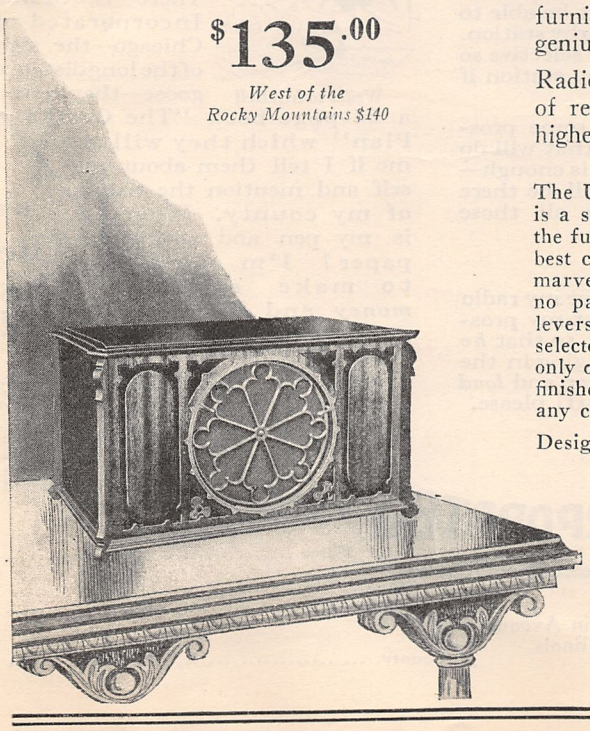

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Write for illustrated descriptive folder

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MODEL L-3

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What I would do if I wanted more money

By J. MATHESON BELL

FIRST of all I'd make up my mind definitely that I was going to get it.

I don't believe any man living can get things worth while without *firmly believing* that he can. Determination will conquer failure anytime, anywhere.

"Busted" and Blue

I'll work harder on my present job to make the boss feel that he owes me more.

But I won't stop there.

I'll put my spare time to work.

I'll quit losing money by making my evenings pay.

I wouldn't give up my present job but I'd make more money by working longer hours.

I'd find something that could be sold evenings, either in my home or some one else's home.

That something would have to be a little out of the ordinary because it would have to be of special interest in the evening.

That would be the time of day when both the man and his wife are at home so I'd find something that would be of interest to both of them.

Decides to Work Harder

I feel sure that such an article would have to be something for the home, something they would both use and enjoy.

So far so good, but what will that something be.

Piano?

Fine, but come to think of it I can't even play one myself so that's out.

Automobile—

Sounds better, guess I could learn how, but seems to me that everybody I know has one. At any rate the auto sounds good—let's see if there is anything better.

Phonograph—

Doesn't sound near so good as the auto.

Vacuum Sweeper—

How Can I Make More?

Not so much interest to the man and I don't see just how I'd show up dust at night.

Radio—

Why, the Sam Hill didn't I think of that before, but let's see if it will do—let's see what its good points are as well as its bad ones.

True—I don't know anything about radio, but I have lots of friends who have learned something about it, so I think I could. What sounds good to me is, that I can demonstrate in the home in the evening, the very time of the day for me, and that's just when all the music is being broadcasted.

I'll have competition. I expect it. I'll have to know just what my demonstration will do that the otherfellow'swont, so lets see what would make the biggest appeal.

Thinks Hard!

Of course, they would be impressed with music from our nearby stations but I feel sure that if I bring in great distances they will be more impressed. It will have to bring in music loud enough so they can sit away back in the room and enjoy it. It must have volume.

They may be satisfied with music from nearby stations, but they'll ask me for distance, so I must be able to get "by" our powerful nearby station. The radio I want must be selective so I can tune out our nearby station if I desire.

I can picture myself in some prospect's home with a radio that will do that, but I wonder if that is enough—maybe my competitor will be there also—maybe he can do all those things as well as I can.

Then where am I?

I've got it—I'll tell you what my radio must do—I want one that my prospect can do all the tuning, so that *he* will get the thrill of bringing in the music from a distance *clear* and *loud* and with a tone that will please.

After all he is the one who is going to operate it, so why wouldn't it be better and best if all he had to do was sell himself. I'll admit I'm not much of a salesman, so if I find a radio that will sell itself then I'll not only whip competition but I'll do it easily.

Gets An Idea—

Best of all, I'll make that extra money I want.

Who knows, I may be so successful at it that I can give up my present job and give it all my time—Gee that sounds too good to be true, but other men have done it so why can't I—I can and I will.

But what radio can I sell that will do what I want and yet sell at a reasonable price—I don't want one so high that my people can't buy—but it must be a good one.

Then when I do sell it, they will want me to fix anything that goes wrong so somebody must teach me how to service radio—that's something I can't afford to overlook.

Where is such a radio?

Where is a manufacturer who will teach me how to sell and how to demonstrate—where I can learn this business, both selling and servicing radio — there must be someone.

Writes to Mr. Bell

There is—Ozarka Incorporated of Chicago—the sign of the long distance goose—they have a 64-page book "The Ozarka Plan" which they will send me if I tell them about myself and mention the name of my county. Where is my pen and some paper? I'm going to make *more money* and I'm going to start *right now* by writing for this book.

10-25

Use This Coupon!

J. Matheson Bell,
Pres., OZARKA, Inc.
122 West Austin Ave. E,
Chicago, Illinois

I am greatly interested in the FREE Book, Ozarka Plan No. 100, telling how I can establish myself in the radio business and increase my present income.

Name.....

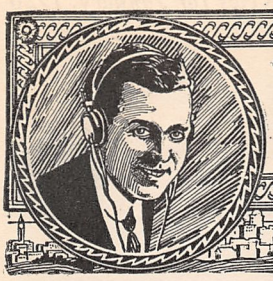
Address.....City.....

County..... State.....

OZARKA INCORPORATED

122 West Austin Avenue E
Chicago, Illinois

122 West Austin Avenue E
Chicago, Illinois



RADIO NEWS

H. GERNSBACK, Editor and Publisher
SYLVAN HARRIS, Managing Editor

EDITORIAL AND GENERAL OFFICES, 53 PARK PLACE, NEW YORK

Vol. 7 JANUARY, 1926 No. 7

WHAT RADIO SET SHALL I SELECT?

By HUGO GERNSBACK

IN the October, 1924, issue of RADIO NEWS, I published an editorial entitled "What Outfit Shall I Buy?" At that time in America the crystal set was already in the decline while the 1-, 2-, and 3-tube sets—particularly the latter—were in reigning favor. In the short space of time elapsing between that time and the present there has been a quiet revolution in the radio industry. Where at that time the 3-tube set was considered an average set, the condition today has changed to one where 4-, 5-, 6-, and 8-tube sets are now on top. Crystal sets, while still being manufactured in goodly quantities, are used only in the large cities for local reception, where they probably will always be used, while the one-tube set is always used by beginners and amateurs, but, in America at least, never for family use.

We have become educated to the 4- and 5-tube sets, and the average set in this country now may be said to be of the 5-tube type. For the past two years the set business in this country has made tremendous strides, and it is practically only in America that sets are in huge demand. In England, for instance, the set business is as yet in its infancy, whereas the parts business is practically 80 to 90 per cent. of all the business done. The Englishman, as yet, does not buy sets, but prefers to buy parts or "components" as they are called there. The reason for this is that in Europe conditions are different from those in America, first as to the broadcasting element, second as to the temper of the population.

In America all broadcast stations operate between 200 and 546 meters. It is, therefore, rather a simple matter to manufacture a set that will take in the entire wave band. In Europe this is not so easy, inasmuch as broadcast stations operate all the way from 186 to 4,000 meters. It has not as yet been common in Europe to build a set to take in this entire wave band without resorting to plug-in coils or complicated switching methods, although in Germany sets of this type are just now being introduced.

It may be said here that Germany is probably the second country after the United States in the diversity of radio set manufacturing, and dozens of different types are being built there at present. In France, too, as well as the rest of Europe, and most of the other countries, with the possible exception of Australia, complete radio sets have not as yet taken the popular fancy, and those that do go in for radio build their own or have some private person build the sets for them.

Here in America several years ago, the cry was "What Set Shall I Buy? Do I wish a crystal set, a 1-tube affair, or a 3-tube set?" Today this is past history and the prospective buyer wants to know "What set shall I *select?*" There is a fine distinction between the two, for the average layman in radio today knows pretty well that what he really wants is a multiple tube set. He knows that his friends have 4-, 5-, or 6-tube sets and he also knows that most of these, if made by a reputable manufacturer, probably perform about the same. In the large cities people no longer buy radio sets on performance only. A study of the subject reveals that today it is the lady of the house who aids in selecting a set. She will probably be more impressed with the looks of the set than with its performance. What she wants is a piece of furniture that will look well in the house, and will compromise with the male members of the family only when it comes to certain technical points on the performance of the set. Quite rightfully, the ladies in the household must be satisfied—first, because the radio set must be an ornament, second, because your wife or your daughter, spending more time in the house than the male members of the family, naturally derives more entertainment and satisfaction from the set. This is not surprising, particularly now that the early morning broadcast periods are taken up with Women's Hours, and that there is plenty of entertainment in the early and late afternoons.

Also, the female members of the household are not interested at all in distant stations. That is, in our large cities. There are so many good local programs on the air that it is not necessary to fish for the distant stations. When a set is selected, however, the male member of the family, like as not, will insist that the set perform for DX work so he can sit up into the wee hours of the morning fishing for stations if he cares to do so. The set, therefore, in almost all cases, will have to perform well, not only for the locals, but also for the distant stations.

Nor is this all. People in America no longer are satisfied with just a set. It must reproduce loudly, must have "lots of pep," as the young hopeful of the family will no doubt tell you, and on top of this it must reproduce sounds normally, clearly and without distortion. Sets that squeal and shriek are falling into disfavor more and more, and within the next two years it will be certain that no one will even think of buying a set that howls and shrieks and grates on one's nerves.

So far this has been the bone of contention of the manufacturers, and rightly so. It is a comparatively simple matter to stop a set from squealing and bring all the stations in clearly, without extra, unwanted sounds. The trouble, however, is that there are still sets in which the squealing is purposely not eliminated. While a well neutralized or balanced set will bring in the distant stations without the squeals, it may be said, generally speaking, that the sets that oscillate and do squeal often bring in the distant stations better than those that do not. Of course, as in all things, there are exceptions to this, because there are many excellent sets that bring in the distant stations wonderfully well without squealing. However, such sets are not as yet in the majority.

Out in the country fifty or one hundred miles removed from a broadcast station, conditions naturally differ from those in the large city. Here the first and only consideration is: "Will the set bring in the distant stations well?" Where there are no locals, naturally we must go fishing and here it is that the distance-performing element becomes the most important one. This is particularly the case with farmers and other dwellers in sections of the country removed from broadcast stations. In such cases, the appearance of the set at times will have to be sacrificed in order to get the correct performance.

For this class of the population the 4- and 5-tube sets are standard today. In other still more remote sections of the country, where performance for the distant stations is the greatest necessity, the super-heterodyne 6- and 8-tube sets may be said to predominate, although even here the 4- and 5-tube sets perform well.

From these remarks it will be readily seen how to select a set this year. If a set is put out by a reputable manufacturer, there will be little choice between the different makes. It will be a matter of personal preference, of which set makes the greatest appeal to the various members of the household, of price, etc.

There is a radio set for every taste and every purse, just as there is a car and a phonograph for everyone.

And, finally, I wish to repeat my recommendation of several years' standing, namely: *"The time to buy a radio set is now."* There is no likelihood of a complete revolution in radio sets for many years to come. The set that was bought last year, the set that was bought this year, and the one that will be bought next year, will perform for many years to come. As a matter of fact, many excellent sets of the ancient vintage of 1923 are still performing well and will continue to do so. It is true that everything improves in time, but that is also the case with everything else. It is the case with automobiles, toothbrushes, or can-openers. All of this, however, does not deter you from buying such articles now and should certainly not deter you from buying a well-made radio set *now.*

Mr. Hugo Gernsback speaks every Monday night at 9 P. M from Station WRNY on various radio and scientific subjects.

Advice to Inventors

By DR. LEE DE FOREST

Dr. DeForest is again with his RADIO NEWS *readers, this time giving them some pointers on the business of inventing and telling some of the good as well as hard luck which befalls this profession.*

INVENTION, like most other occupations of man, is a profession with its rules and regulations, its form and efficiency, its ethics and organization. As a profession it, of course, has certain ideals and methods of workmanship which, if looked to properly, bring success to the inventor and, if slighted, result in his failure.

For almost every other craft in which men earn their bread and butter there are endless articles to guide the tyro, all sorts of advice by which he may judge his business actions, and a great wealth of lore which is given out by those who are older in the game than himself. Not so with the inventor, however. With him, for the most part, he must find his own way, and by the process of trial and failure, discover what is the best principle.

If this state of affairs could be circumvented, what a lot of trouble, failure and disappointment could be spared the young man who wishes to spend his life investigating ways and means of lightening the burden of our lives!

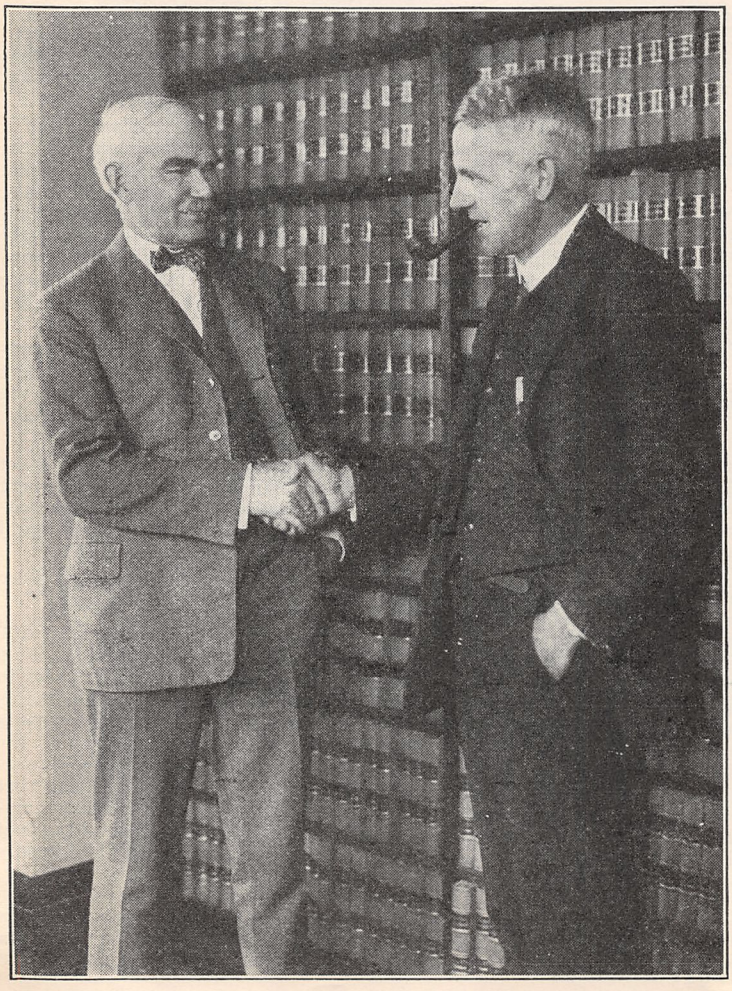
But lest those interested should think that a few simple rules will settle the whole affair, it must be added that even with the best of intentions and a perfect fulfillment of the rules, once learned, there is a host of things which may combine to defeat the best of us.

One instance of this is clearly shown in one of my experiences back in the early days of radio, then called wireless. Until the later part of 1899, all the experimenting that had been done with wireless had employed a sounder of the common telegraph variety for reproduction of the signal sent out from the transmitting station. This necessitated the use of a relay of some sort which would give a comparatively large power output, or at least could be used to control fairly large amounts of power.

Everyone acquainted with the classical experiments in radio will recall the old coherer and the complicated polarized relays and various other sensitive apparatus which was employed to form the receiving end of the station. All of the early experimenters used this system and, as a consequence, all advances made up to that time worked with the use of the sounder in mind.

The simplest mathematics will tell that a telephone receiver is much more sensitive than a sounder which has to have enough power to pull down an armature against the pressure of a spring. This struck me from the first experimenting I did in the field back in the old days in Chicago.

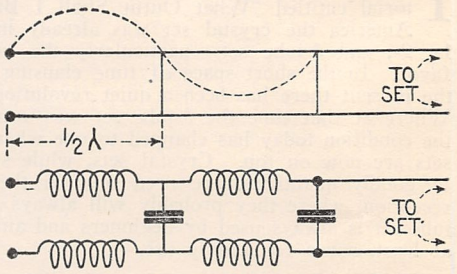
As soon as I started work on the old "goo responder" I incorporated the use of telephone receivers as the reproducing agent. But due to financial circumstances and to my lack of knowledge as to the proper procedure in such instances, I failed even to ascertain whether a patent could be obtained on the idea. It was only a short time after this, when the first of my work became known in the radio field, that everyone took up the use of the telephone receiver as the most logical and best method of making the signals audible to the operator.



One of the happiest days in Dr. DeForest's life was the morning following his final winning of the suit giving him control of the oscillating vacuum tube patent. In the photo at the left he is seen being congratulated by Mr. Roy Weagant (whose own name is not unknown to radio) in the doctor's office.

This was an idea so simple that those who enter the field today think nothing of it. But at that time, it changed the whole face of experimenting. It changed entirely the direction of research work for receivers. But the point is that the idea, no matter what its value, netted the originator nothing, because of the peculiar circumstances under which it was conceived. It is just such situations as this which are the bane of an inventor's existence.

This situation may arise—and probably



Back in the early days, about 1906, Dr. DeForest in experimenting with short waves, ran into the design of filters. Above is the Lecher wires and below the later filter design deduced from it.

does—because most inventors do not have the advantages of an apprenticeship to their trade, no training in the technique of the business end of their art. Some will say immediately that the best procedure in such cases would be for the youngster seeking to enter this field to spend some years in the laboratory of one of the large corporations.

This might be a good plan, were it not for the fact that such work tells on the mentality of the individual performing it. It creates habits which tend to destroy originality and inquisitiveness in all but the most hardy. This statement, like most others of so blanket a nature, finds many exceptions in practice, but it is nevertheless true in large outline. As is well known, such institutions are run according to a very definite plan. The men are given some particular line of work for investigation. They must follow this line with the solution of some certain problem in mind. Also, if they happen to stumble upon something interesting in the process of their work, the completion of it is liable to be given into the hands of some other worker.

The worst of it is that this particular system tends to force the mind of the investigator into a sort of rut. It is impossible for it to do otherwise, when he is forced to work toward the solution of some particular problem. And often as not the problem is of mere mechanics.

This is aside from the remuneration to be derived from such work. Of course, the worker is assured of a soft berth for life and easier treatment in the matter of routine if he produces something worth while. But if he produces real results he does not, in many cases, reap the total reward for it.

On the other hand, there is the use of a well-equipped laboratory and all the necessary time and apparatus for experiments of the most abstruse nature. But, considered on the whole, more ill results from it than good—that is, for the real inventor.

Then there is the possibility of an invention being made too soon. There are two cases in point which may well be cited. One of these, and probably the most important,

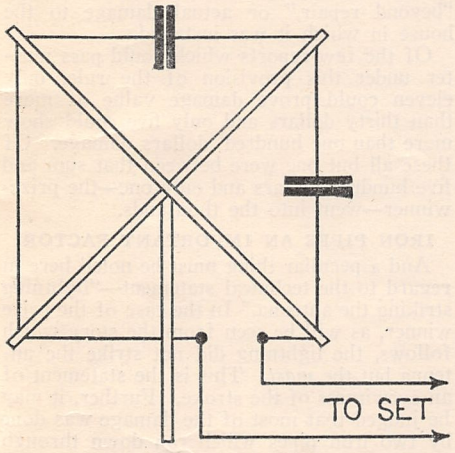
is the use of the wave chute for directive transmission. In my book of patents there is a drawing and description of such a piece of apparatus under the date of 1906. The scheme was a perfectly good beam transmitter and could have been used with perfect ease for such purposes as that for which the new beam stations are being employed in England.

And as a logical outgrowth of this same idea there is another patent on the use of directed rays for a sort of radio lighthouse. This consists simply of a Hertzian oscillator placed in the center of a parabolic reflector which consisted of metal rods fixed on supports. The whole thing, reflector and oscillator, was to be rotated on the support and arrangements made so that the revolution of the projector should change the signal sent out in accordance with the direction in which it was facing at that particular moment.

It has only been in the last year that use has been made of this idea, and it has been done now only in England. Quite recently there has been constructed near one of the shores of the tight little island just such an arrangement as that shown in the patent—a revolving beam reflector with an arrangement for changing the signal in accordance with the direction of the transmission.

In other words, it might be logically said that the invention was made too early because it has come into use only after nineteen years from its inception—two years after the expiration of the patent.

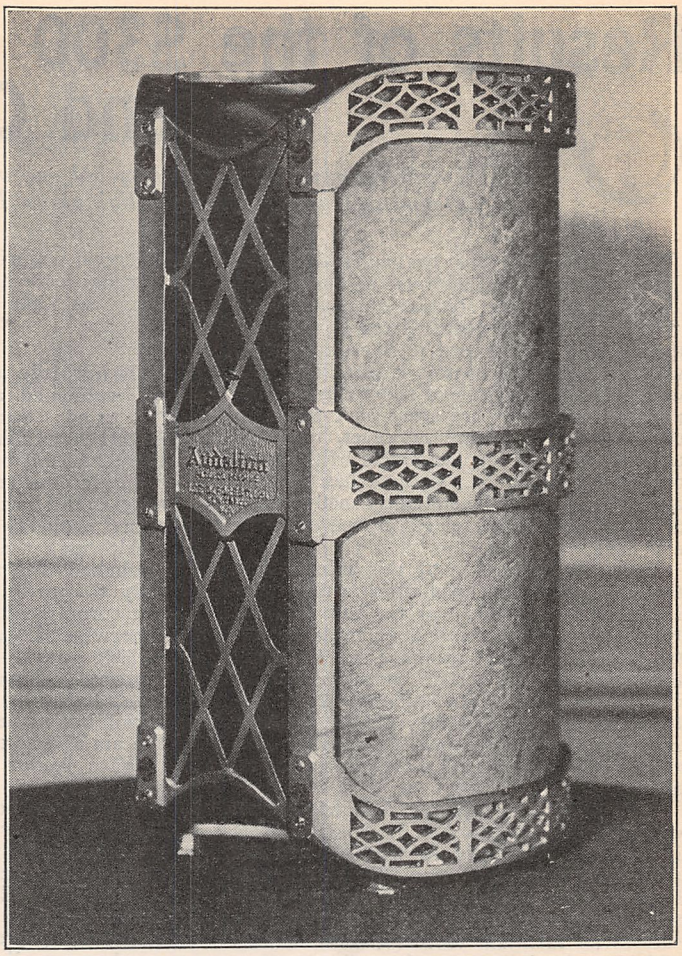
Another such case is the work done and patents received for Lecher wire receivers made about the same time. There are four such patents. Incidentally, these have not come into use yet, but the present trend toward the use of the ultra-high frequencies may yet bring them into the forefront of radio. It should be said that they have not come into use in the original, but from them has been derived one of the best filter systems known today. In one of the accompanying sketches there is shown the original receiver and the adaptation which makes it a filter. When employing comparatively long



First loop antenna to be used in radio was designed by DeForest. Above is a diagram of it. Note the condensers.

waves, the length of the wire necessary for them becomes too great for practical purposes, so it was necessary to substitute coils for the straight lengths. With this, there was added the condensers for the bridges. Of course, high capacity condensers are as good as a short circuit to high frequency waves, so they could be substituted easily. Look at the second of the two sketches. It is a perfectly good filter system such as is in regular use today.

But in those days there was not nearly so much known of the business of tuning as there is today. In fact, very little was known concerning the complicated mathematics of tuning and so much of the work done along that line was by the cut-and-try method.



Dr. DeForest's latest invention is a new type of loud speaker. It is shown in the photograph at the right. After the perfection of his new and now well-known phonofilm, he found that none of the then existing speakers gave sufficient fidelity of reproduction, so he designed the one shown herewith. The unit is in the center and the parchment is alternately pulled and pushed by the sound vibration.

That is what makes the discovery of this filter system of some real importance. It has been only in the last ten years that we have learned to handle the very complicated mathematical idea underlying the action of this same filter. One thing we did know for certain in those early days. It made a station very selective, that filter—very selective, indeed.

Another point which must not be overlooked. The inventor, as well as the scientist, has to give a lot to the art for which he gains no compensation at all. Another instance of this is the adaptation of commercial frequency alternating current and transformer design so that available supply could be used instead of primary cells or storage batteries. In the early days, almost all the transmission was done with huge condensers and extreme voltages generated with the aid of spark coils of Gargantuan proportions. This complicated matters greatly. Entirely aside from the cost of the current, there was, of course, the necessity of constructing all parts to withstand the most enormous voltages. When the operator wanted to get a little more distance out of the old rock-crusher, he simply pulled the electrodes of the gap a little further apart. Presto, he raised the voltage and at the same time the signal strength at the receiver. But, by the same token, he raised the overhead for the boss, because almost invariably plunk—and another faithful condenser plate would breathe its last, unable longer to stand the strain.

With this situation in mind, the only current transformer to take the place of the logical step was to design an alternating current transformer to take the place of the spark coil. Much better effects could be obtained with it and a great number of condenser plates saved.

But—and, as always, there was a but—there was nothing known in those days concerning transformer design for this purpose. The only thing which could be done was to set about it. Now the mathematics of the construction of an alternating current transformer is a very simple matter to one who has had a course in electrical engineering. But it is quite another thing to make it work effectively after it is put into operation. Also, the Holtzer Cabot Company, which made the first of these monstrosities, insisted on being paid for the trouble, which was a more or less distasteful matter when the transformers insisted on burning out when some over-zealous operator tried to work transatlantic stations on two kilowatts spark.

But as more and more of the transformers were built we learned more and more about the art of insulating them. Not, however, until a small fortune had been paid to the above-mentioned company. All this had to be given the art and no remuneration whatever could be reaped directly from it. Of course, revenues from the company paid the expense, but in those good old days, wireless companies were run for the most part as a deficit—a good fat one.

Then, of course, one must be prepared for defeat at one's own "dumbness" or the entanglements of routine—whichever you wish to call it. Those who have read the biography which appeared in RADIO NEWS during the last year will recall that during some experiments on the Connecticut shore, there was an experiment performed which some fifteen years later was rediscovered and proved to be one of the most important factors in long-distance reception through interference from atmospherics. I speak of the Beverage type of antenna.

At that time there was great business afoot in the form of landing a fat government contract for the Navy, which meant a great deal to the DeForest company—a very great deal. It meant bread and butter, in fact. But it happened that the elements were none too well disposed toward the fate of the DeForest company, and a rather too healthy windstorm took away the antenna. Some-

(*Continued on page* 1065)

Results of the $300 Lightning Investigation and Contest

This article throws light on a very old and much mooted radio question—viz., whether a radio antenna increases danger from lightning. It is a result of a contest held by RADIO NEWS.

EVER since the beginning of radio, we have had with us the question of whether the erection of an aerial increases the danger from lightning to the building upon which it is erected, or in which the radio equipment is installed. The matter has been discussed many times in the journals and many engineers have taken up the possibilities of it. However, until the time of the recent announcement of the prize contest by RADIO NEWS, there has been no attempt to compile by statistical methods, the actual number of houses struck and the damage done.

Until the publication of this information, the only foundation upon which a real opinion could be founded was the fact that the Fire Underwriters Association made no extra hazard of radio installations. Certainly they required that certain code practices be complied with in the installation of the antenna and the set, but they did not increase insurance rates on property occupied with radio equipment or near which there was an antenna.

Very little, if anything, is definitely known concerning the daily habits of lightning. This is the case from both the practical and the theoretical point of view. Some attempts have been made to learn the laws of lightning by the empirical method, but with little success so far. In fact, the only results which can be drawn even from this attempt, is a general rule as to the chance of lightning striking a building equipped with an antenna.

As is well known to the constant readers of RADIO NEWS, an announcement was made in the editorial of the July issue to the effect that a prize of $300 would be paid to the person who could show that lightning had struck a radio set and caused real property damage, the prize, of course, going to that account which showed the most property damage with the provision that it should be thoroughly authenticated with the affidavits of two witnesses beside the person to whose property the damage was done.

IN our July issue of last year we published a prize contest entitled "Summer Radio." RADIO NEWS contended that there had not been, up to that time, a single case reported where lightning ever struck an aerial, causing actual property damage.

Although the contest was widely published, for months, there were only 60 entrants, 59 of which did not comply with the rules or were otherwise disqualified. The prize of $300 goes to Mr. F. K. Dalton, of Toronto, Canada. Even in this case, lightning did not strike the aerial, but rather the mast to which the aerial was attached.

With about five million radio sets scattered all over the world, the chances are therefore one in 83,333 that your aerial will be struck by lightning, which, it will be agreed, is practically nil.

RADIO NEWS, therefore, still maintains that a radio aerial is an excellent protection, acting very much as a lightning rod for all practical purposes.—EDITOR.

WIDE SCOPE OF THE CONTEST

It may be considered that most—or at least a great majority—of all those interested in radio were appraised of this contest. In many cases the announcement of it was picked up by other journals and run, thereby giving the contest wider circulation and, in one instance, an entrant was advised of the contest by an insurance company. Then, to add further to the publicity, the announcement of the contest was read on one night each week from RADIO NEWS station WRNY. This, of course, added hundreds of thousands more to the list of possible contestants.

These and other facts may be used as a logical foundation for our assumption that news of the prize reached almost every individual who might be interested in it because of lightning damage. If this be the case—which we will suppose it to be—the results which may be drawn from it may be considered as fairly accurate.

WHAT THE RESULTS SHOW

As to the results themselves, it can be said first, that as a matter of fact, the erection of an antenna in no way increases the danger of a building or property from lightning damage. Out of a total population of this country added to that of Canada and some other foreign countries (we include these latter, for the prize goes to a Canadian, and there were entries from other countries) less than sixty replies showed actual cases of *lightning* striking an antenna and causing damage.

Now the next interesting point is that out of these cases, only fourteen reported damage in excess of fifteen dollars. In the majority of reports the total loss consisted of a burned-out transformer, a blown tube or a ruined lightning arrestor. These are all small cases and do not come within the meaning of the contest as was plainly set out in the rules, which are reprinted at the end of this article.

It was specifically stated in the particulars of the contest that real property damage was to be construed to mean something more than the burning out of one or two pieces of apparatus in the set. Property damage was to mean the complete demolition of the set "beyond repair," or actual damage to the house in which it was installed.

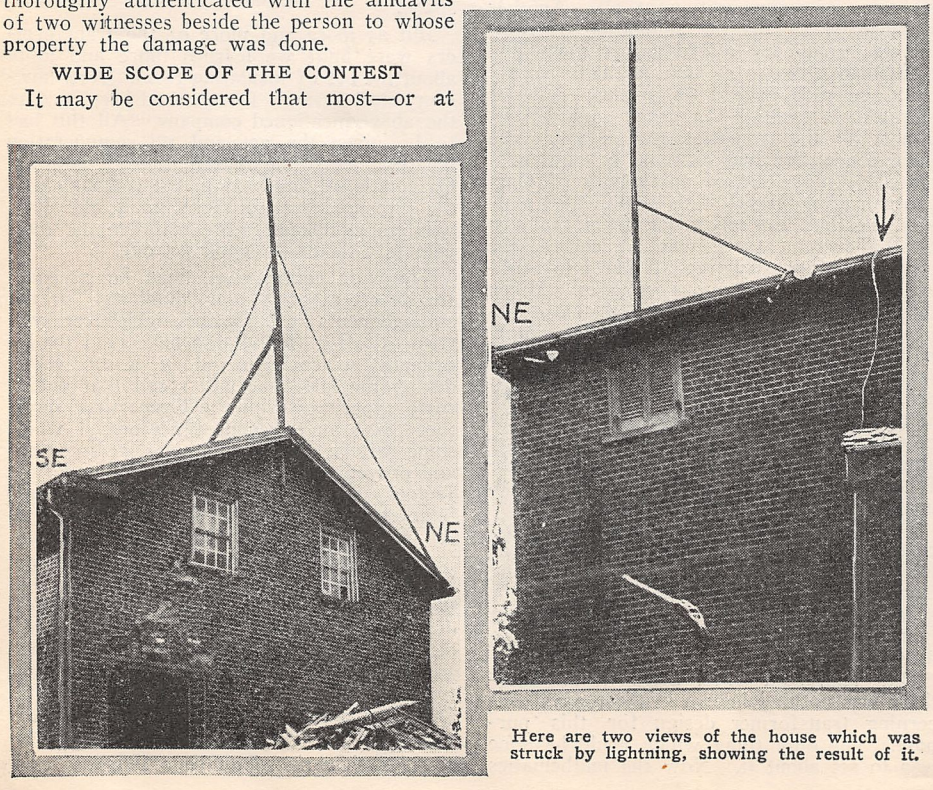
Of the few reports which could pass muster under this provision of the rule, only eleven could prove damage value of more than thirty dollars and only five could show more than one hundred dollars damage. Of these all but one were between that sum and five hundred dollars and only one—the prize-winner—went into the thousands.

IRON PIPES AN IMPORTANT FACTOR

And a peculiar thing must be noted here in regard to the technical statement—"lightning striking the antenna." In the case of the prize winner, as will be seen from the story which follows, the lightning did not strike the antenna but the *mast*. This is the statement of an eyewitness of the stroke. Further, it may be judged that most of the damage was done by two iron pipes which ran down through the center of the house and ended several feet from the antenna.

Had it not been for these, it might easily be imagined that the damage would not have been so extensive as it was. It will be noted that very little damage was done to the radio set itself.

Following is the prize-winning account with full details.

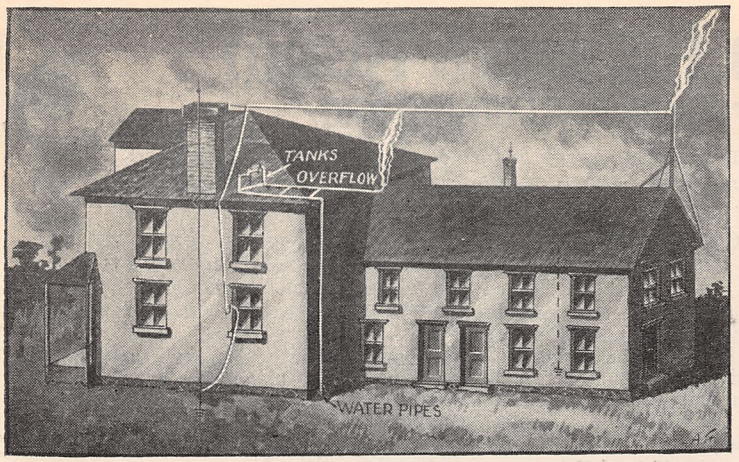


Here are two views of the house which was struck by lightning, showing the result of it.

PROPERTY DAMAGE BY LIGHTNING CAUSED BY RADIO INSTALLATION

By F. K. DALTON

On Saturday, May 23, 1925, at 8.30 A. M. Eastern Standard Time, lightning struck the antenna mast erected on the dwelling of Mr. E. C. Monkman, farmer, about two miles east of the town of Brampton, Peele Coun-



Here is an artist's sketch made from the description of an eye-witness. It explains how the stroke hit the mast.

ty, Ontario. The main part of the lightning stroke left the aerial and passed down through the house, resulting in almost complete destruction of the front part of the building. The damage is estimated at about $7,000.00.

A description of the installation and details of the accident are given in the following paragraphs, and illustration is supplied by the accompanying photographs and drawings.

THE INSTALLATION

The residence of Mr. Monkman was a large two-story brick building with shingle roof and contained about sixteen rooms. Two metal water tanks were located in the attic and the iron overflow pipe projected beyond the eaves at the centre of the house. The metal feed pipes to these tanks were within the house, and were enclosed in a wooden box approximately three feet square, which was filled with shavings to prevent the pipes from freezing.

The aerial, inverted "L" type, consisted of one stranded horizontal conductor, about 65 feet long, running east and west, supported by a chimney at the west end and by an upright wood mast at the east end. Electrose ball strain insulators were used, one at each end.

The lead-in wire tapped the aerial at the west end and passed down the south side of the house entering by a lower window through a porcelain tube. Where it passed the eave it was kept out about two feet from the metal eavetrough by a porcelain insulator on a wooden pin.

Outside the window a model UQ-1310 lightning arrester was mounted and connected with correct polarity between the lead-in wire and a good lightning-rod ground directly below. This arrester was manufactured by the General Electric Company in the United States under patents of June, 1915, and March, 1916.

The arrester was not bridged by a ground switch.

The radio receiver consisted of a Crosley VI—one stage radio frequency amplifier and detector—and a Crosley IV—two-stage audio frequency amplifier—with tubes respectively as follows: UV-201, UV-200, 2-UV-201A.

The receiver was grounded on the water pipes inside the house, thus the operating ground and lightning ground were separate.

The building was fitted with lightning rods several years ago but these appeared still to be in good condition.

THE ACCIDENT

During a severe electrical storm one heavy flash struck the antenna mast at the east end of the aerial. Mrs. Monkman witnessed the stroke and saw the mast splintered at the top.

The stroke followed three paths to ground.

Part of the stroke ran down the mast to the guy wire, and down the northeast guy wire to the eavetrough, splitting the cornice. It then followed the eavetrough horizontally about 20 feet to the downpipe and ran down this pipe to the cistern, splintering one of the boards which cover the cistern. No further damage was caused by this part of the stroke.

A small part of the stroke followed the aerial and lead-in wire to the arrester and receiver and then to ground. The arrester was not damaged, being found in good condition after the accident, and without any evidence of heat or burning in the supports by which it was mounted, but in the receiver the first variable condenser (folding type) was destroyed; the moulded part had been blown to pieces.

No further damage had been done in the receiver, or elsewhere on this path. None of the tubes were injured as all worked well after the accident.

The part of the stroke which caused the serious damage ran along the aerial only a short distance to a point directly above the overflow pipe of the water tanks, and struck downward a distance of several feet to the overflow pipe. It passed to the feed pipes and followed them to ground, setting fire to the shavings around them, and causing considerable disturbance in the water within them, forcing sediment from the trap into the wash bowl. The sediment was observed by Mrs. Monkman just after the stroke.

The tanks were in a room about 12 feet square. Mrs. Monkman discovered smoke coming through the eaves near this room and on opening the door of the room found it to be full of flame. The rest of the attic was full of smoke but she did not see any flame there.

The fire spread rapidly and completely gutted the main part of the building, but the kitchen and woodshed adjoining were saved by volunteer help.

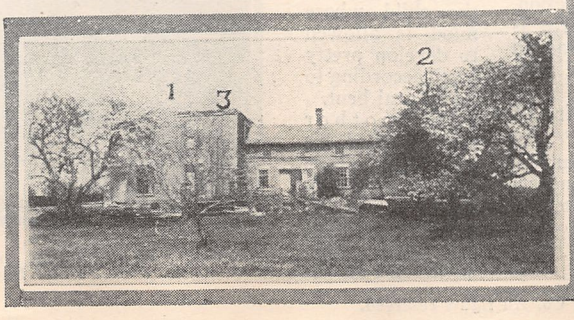
RULES OF THE CONTEST

For the benefit of those who do not remember the contest as it originally appeared, there follows below a reprint of it in abridged form.

THE RULES OF THE CONTEST UNDER WHICH THE AWARD WAS MADE

1. Any one may compete in this contest.
2. Only radio installations with outdoor aerials and a standard make of lightning arrester are eligible as entries in this contest.
3. The usual ground connection, such as water-pipe, radiator, or any other good and equivalent ground connection employed in standard practice, must be used.
4. A sworn affidavit, sworn to by two responsible individuals who have inspected the damage, must be submitted to RADIO NEWS.
5. Proof must be furnished that such damage was not caused by other means, such as explosions from gas, etc., fire from chimneys, etc.
6. A photograph of the damage caused by lightning, either to the radio set or to the building, must be submitted.
7. A story, of not more than 1,000 words, giving minutely the extent of the damage, time at which lightning struck, and other valuable information, must be submitted.
8. No entries will be considered under this contest where no real damage has been done. By *real damage* we mean that (1) Lightning should have set fire to the house, (2) lightning should have wrecked part of the building, without setting fire to the house, or (3) lightning should have wrecked the radio outfit entirely, damaging it irretrievably, or (4) any of these three combined. The burning out of a transformer, or of one or more tubes in a radio set, would not be considered as real lightning damage, under these provisions, the intent of the contest being to prove that lightning never does actual property damage to any extent.
9. The prize will go to that entrant who, in the opinion of the judges, shows the greatest damage (money value) done by lightning.
10. In the event that more than one individual reports an identical damage in money value, the one who furnishes the best description and the best photographs will be entitled to the prize.
11. There will be only one prize—namely, $300.
12. This contest closes on October 10th, 1925, when all entries must have been received. RADIO NEWS hereby pledges itself to publish any and all entries, even though they do not win a prize.

For those who are interested in the question of lightning discharges, it may interest them to look back the last issue of RADIO NEWS, *and read over an article entitled, "Is Lightning A.C. or D.C.?" Although this article will not go far as concerns lightning striking a house, it will undoubtedly prove of interest in connection with the present article.* —EDITOR.



(Below) One represents the location of the tanks, while 2 shows the point where the mast stood. 3 is the location of the pipes. At the right is shown the lead-in point.

Thirty Years in the Dark Room

The Experiments of Dr. D. McFARLAN MOORE

This biography, written by W. B. Arvin of RADIO NEWS, *gives a history of the early experiments in gaseous conduction and television made by one of the most interesting of present-day scientists.*

D. McFarlan Moore at the time he entered the electrical world. From an old drawing.

IT is said that ministers' sons, like all Gaul, are divided into three parts. One-third go promptly to the devil, the second third are never heard of and the last third rule the world. Possibly this rule is not iron-bound but an analysis of the names in "Who's Who" will show a large percentage of ministers' sons and daughters among the list, a larger number, in fact, than may be found among the progeny of any other class or profession.

Daniel McFarlan Moore is the son of the Rev. Alexander Davis Moore and Maria Louisa Moore neé Douglas.

DR. MOORE'S FAMILY

His ancestry is a good point in proof of the Mendelian law. There were a number of prominent people on both sides, and a certain amount of inventive genius. The outstanding traits of the previous generations may, in a broad light, show the development of the character of the man.

His grandfather was a "powder monkey" at the storming of Fort McHenry during the siege in which the "Star Spangled Banner" was written. After the completion of the Revolution and the installation of the Republic and the removal of the capital to Washington, he established the *National Intelligencer* in Washington, D. C., and became editor of it. This organ thrived during the early years of the government and was a more or less influential journal in politics and social affairs. There are, of course, many tales concerning his connection, direct, with the early governments and it is said, what record remains, that he was an individual who was well connected in governmental affairs.

Beside these works he was Grand Sire of the Odd Fellows lodge.

An uncle of the inventor, Col. William G. Moore, was secretary to President Andrew Johnson. His portrait may still be seen in the White House. Among Mr. Moore's maternal ancestors were Sir Arthur Johns and the Earl of Gray. His great-great-grandfather was Col. Archibald Orme, member of staff to General George Washington.

There is also an ancestral connection of the family with the famous Douglas of Scotland, the "King Maker." The connection is fairly well traced and contains a great many other names intimately connected with the Highlands and Lowlands of Bobby Burns' famous country.

Moore was born on the 27th of February, 1869, at Northumberland, Penn. His father, a Presbyterian minister, had charge of the local church, was a respected member of the community and a force in local affairs. Also, he was a gentleman of the old school and held ideas concerning the regulations of family and the conduct of children which seem strikingly peculiar to the present generation. Moore's earliest remembrance of his father is of sitting in his father's library, the walls lined with books, and watching his father, before a desk, poring over manuscript or book, in deep study. He worked a great deal of the time, having no regular study hours. Evening or daytime, it made not the slightest difference to the studious minister.

This may be the cause of one of Mr. Moore's most characteristic habits. This and his early connection and knowledge of Thomas A. Edison, in the early days of the development of the electric light. Mr. Moore, following the example of his father, early assimilated the habit of working almost constantly. Then when he entered the electrical field he was in constant touch with Edison and again found a man who worked almost constantly. So the habit, having fixed itself on him early, has never left him.

HIS EARLY YEARS

His early childhood was spent at home and was the ordinary life of the growing boy. There was interest in everything, just as one usually finds in the child whose mind is allowed to develop pretty much according to its natural bent.

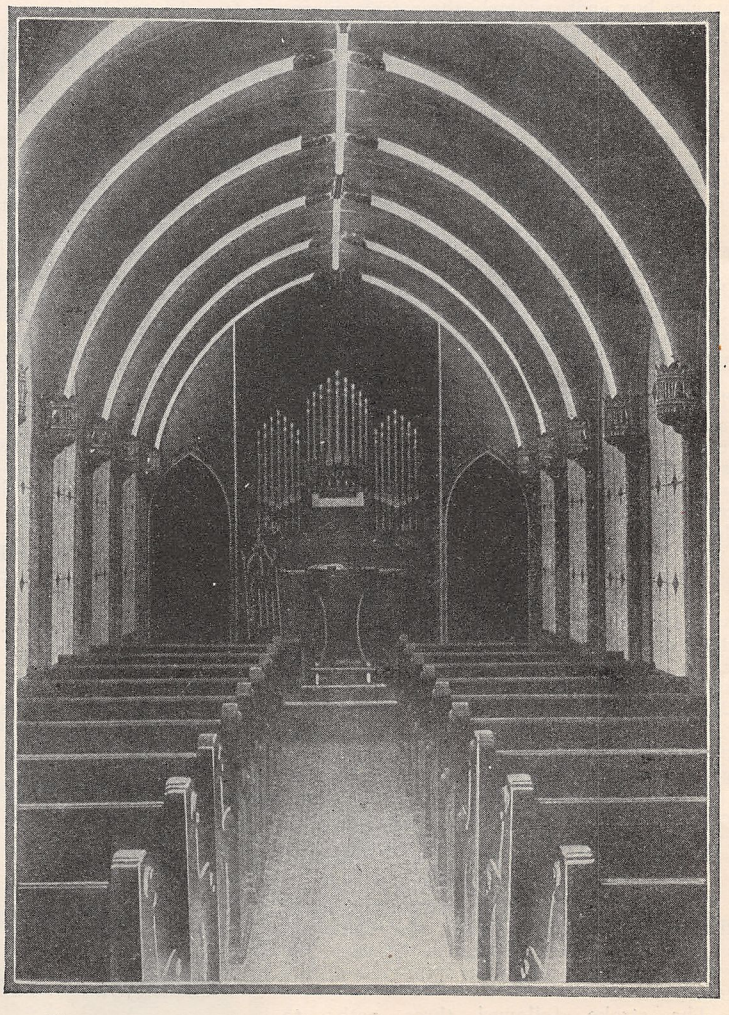
His mother early started his education. There was the learning of the alphabet and the first reading lessons. He was able to find his way about the printed page pretty well and knew something about arithmetic before he entered school. This enabled him to have a start a bit ahead of the average child.

From the time of his entry until he was thirteen years of age he attended public school in Pennsylvania. At the completion of this work he was sent to Moravian Parochial school and then later to Ulrich's Preparatory School.

At five years of age he received his first pair of trousers and a toy drum. Shortly after he was sent to a private school. From the time of his birth to 1876, the Moore family lived in Northumberland. In the middle of that year, however, they removed to Bethleham, Pennsylvania, where they remained until the completion of D. McFarlan's education, in Lehigh University.

All his early formative years were spent in Bethlehem. While going to school he managed to get in most of the experience usual to lads. One curious point, however, is that one of the clearest remembrances left to him is a vision of an old brick kiln which stood close to the house where he lived that had been used by the famous scientist, Priestly. At that time the kiln was being used as a sort of community chicken house!

There was the usual run of boats, sail



The great showing of the Moore lights in the "cathedral" at the first New York electrical show.

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and power. The latter type used rubber bands to furnish the turning force for the side wheels. Later a steamboat was built which ran under its own power.

During his boyhood he seemed to have had a *penchant* for transportation. The billy goat which the boys procured was immediately used to draw all sorts of vehicles from sleds to the most complicated wagons. When the boys—D. McFarlan and his brother—built a steam engine which actually worked, the first step, upon its completion, was the construction of a sort of locomotive on spool wheels, which, by means of various belts and reducing pulleys, he made the steam engine propel.

THE FIRST WORK-SHOP

As he grew, he established a sort of work-shop in the garret. One corner of the great loft under the eaves was set aside for his use and it was filled with orderly rows of packing boxes filled with all sorts of useful and useless things. Here, in the winter afternoons when the weather was too bitter to permit of much sport out of doors he employed his time doing something in the work-shop. Here he manufactured everything from kites to frictional electric machines. Very little was generally known at the time concerning electricity as it is known today. The only knowledge of it given in the primary schools was a short discussion of frictional or static electricity in the old text-books on "Natural Philosophy."

His early boyhood was a particularly healthy one. There was no end of outdoor sports and exercise. There was football at school. In the wintertime there were all sorts of sports, fights with snow balls from forts which required several days to erect, fights with bows and arrows and spears. During one of these fights he was pretty severely hurt and had to be taken home.

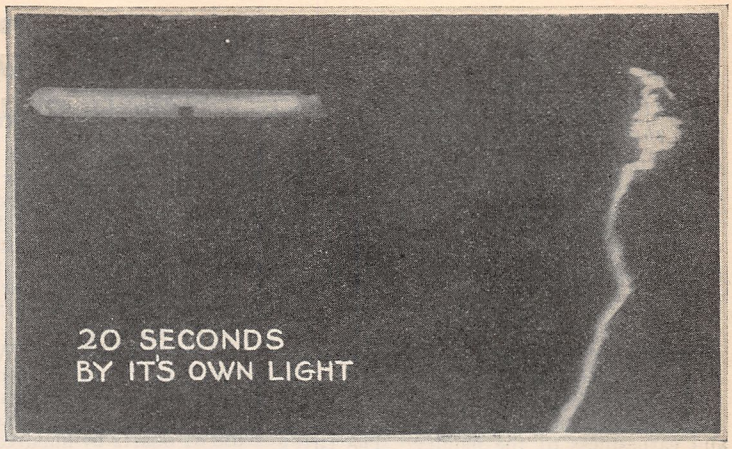
Then there were excursions to the Steel Works, with all the thrills attendant for a growing and interested boy. Many times he went through the great machine shops, the blacksmith shop with its huge hammers and hot fires, and then, best of all, there were rides on the locomotive which ran around the plant carrying the various products from one part of the mill to another.

Then as he grew older, the consciousness of poetry and literature grew upon him. His father was a graduate of Columbian College and a theological seminary and so was a thorough classicist. His mother, also was well educated and so Moore was given a very, very standard diet in prose and poetry. His father's library contained many books of interest and he read many of them. His mother inculcated a taste for poetry, which he still holds.

Each Sunday afternoon was given over to more quiet activities than the remainder of the week. It was during these periods in which he obtained most of his love for poetry. His mother would recite it by the ream and then finish the sitting by reading him more. The training must have been extremely thorough, for at the present time he is able to quote more than ten thousand lines of verse from standard authors.

All during this period of life he had to take care of a regular part of the chores for the home. There was wood and kindling to be prepared each evening, coal to be brought in for the various fires and a certain amount of work to be done about the house. During the summer months there was garden to tend and in the autumn leaves to be raked up, burned and the ashes sprinkled over the garden.

He, with his brother and other boys, engaged in long hikes over the surrounding countryside. Early he started camping and fell in love with it. The life was a hardy one and he thrived upon it.



The photograph reproduced herewith shows just one of the mysteries with which the inventor is often confronted. At the left is a vacuum tube light while the irregular light at the right is a mystery. The ragged line is not a light at all, but the wire supplying the current to it! X-rays, possibly. Anyway, electrical emanations from the wire affected the photographic plate. It's still a mystery.

THE fact that D. McFarlan Moore was one of the first experimenters to go deeply into the effect of currents through vacuum tubes is not generally known. However, in one of the illustrations included in this, the second installment of his biographical series, there is shown one of his first tubes with an accompanying mystery as to its characteristics which is very close to X-rays. It must be kept in mind that this experiment as well as most of Mr. Moore's work was done before there was anything published of the experiments of Geissler or Roentgen—or at least before anything of it was known in the United States.

He has been in radio since the first, having taken out television patents as early as 1903, and having made the first vacuum tube for radio.

—EDITOR.

FIRST INTEREST IN ELECTRICITY

One day his mother called him into the house and sent him to the home of a neighbor to borrow a copy of the *North American Review*. He brought it home and delivered it to her. She glanced through it and just as he was about to run out to his play fellows, his mother told him that there was an interesting article in the magazine which she would read to him later.

The article told about the work of a young experimenter in a New Jersey town who had devised a method for using electricity for lighting purposes for the home. It seems he had just invented a sort of light which consisted of a thread coated with carbon and suspended in a glass bulb from which the air had been extracted. The article set fourth the claims of the men interested in the work and had a small story from Mr. Thomas Alva Edison, inventor of the device. The editors, however, did not seem to think that the future of this little piece of apparatus was quite so bright as claimed by the men working on it.

Moore was very greatly interested in the article and proceeded to find what other knowledege was available on the subject.

It was the following summer that he made his first camping trip and incidentally had the first thoughts about his future. With friends, he constructed a canoe, and made a trip from his home town, Bethlehem, to Lake Hopatcong in upper New Jersey.

At the preparatory school he continued his studies along the classical lines while at the same time he kept constantly on the watch for engineering subjects.

He entered Lehigh University and stayed at home. Through the advantage of a scholarship, he was enabled to take his course almost free of charge. As is usual in the case of ministers' families, there was very little money available for anything except the necessities of life. This fact caused Moore the greatest anxiety during his school life.

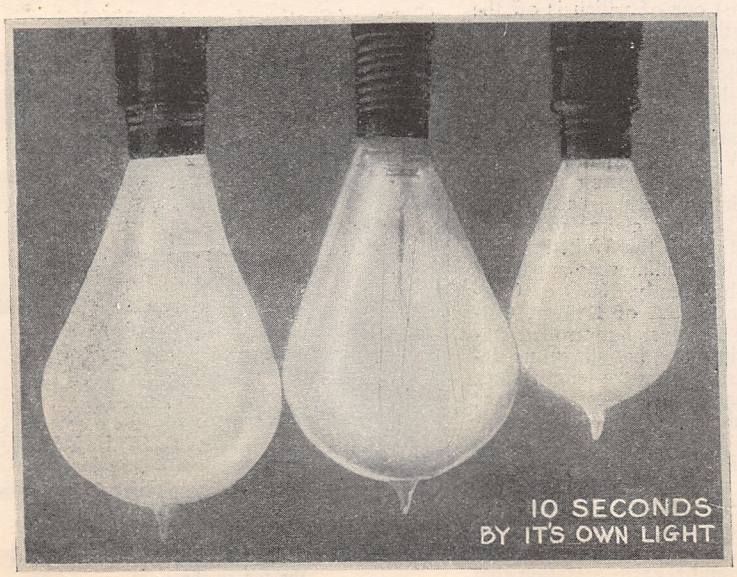
The pressure exerted by financial and religious conditions at home caused him to be left entirely out of the social life of the school. Moore took advantage of every possible bit of it but that was very little. He continued in his studies and gave the extra time to his school work.

At that time there was, of course, no such thing as an electrical engineering course to be had in this country—or in any other for that matter.

EDUCATION

His course was the regular course offered with the degree of B. Sc. He took all the

(*Continued on page* 1077)



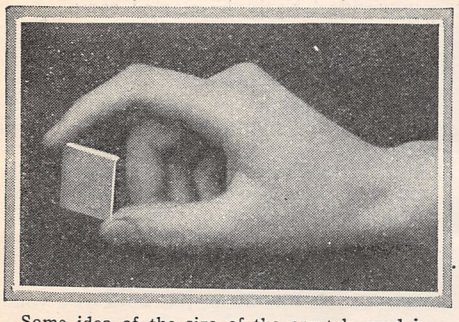
Left: A comparison of the Moore light with the wire filament type. Note particularly the difference in the quality of the light. The Moore lamp has the gas filament of the positive column type. This work, it must be remembered, was done before Geissler published the results of his experiments.

Quartz Crystals Control Wave-

By S. R. WINTERS

THIS article of a general nature and the one on the following page of a more technical nature should explain thoroughly the operation of the latest in radio transmitters. Crystal control makes the use of short waves commercially practicable. The two articles are a unit.

THE difference between the famous search of the ancient Diogenes and the recent search of radio amateurs is that of purpose rather than intensity and earnestness of the inquiry. The Greek cynic philosopher was exploring into the thoroughfares and byways of Athens for an honest man; modern radio experimenters or amateurs, with a zeal no less intense, are combing jewelry stores, optical establishments and sundry other places for pieces of glass or crystalline minerals suitable for controlling their radio transmitters.



Some idea of the size of the crystals used in broadcast work may be obtained from the photo above. Note the small crack in the crystal being held. Refer to opposite page.

GROWING IMPORTANCE OF CRYSTAL QUARTZ

This simile, though somewhat far-fetched, suggests the importance that is being attached to crystal quartz as a means of confining transmitting stations precisely to the frequencies or wave-lengths assigned. This substance possesses the so-called piezo-electric effect, which means that a small piece of this crystal will oscillate at a constant frequency when electric energy is impressed upon it. In effect, it has the magic properties of holding the transmitter at a particular frequency—bearing resemblance to the function of a governor on a steam engine.

If, however, the virtues of the crystal quartz were restricted to the proper functioning of the transmitters there would be little occasion for stressing its importance. Its wholesome effect, however, is not confined to the transmitting room of the broadcast station but, if adopted for service by the 560 broadcast stations, the owners of the estimated 5,000,000 radio receiving sets will have less cause for complaint with respect to interference. For, according to results of experiments conducted by the Radio Laboratory of the Bureau of Standards, static is not the chief offender in marring the clarity of our radio programs but interference from other broadcast stations contributes a major part of the disturbance in reception. This implies that the transmitting stations are not operating precisely on the frequencies assigned. Quartz crystal, theoretically, will correct this evil.

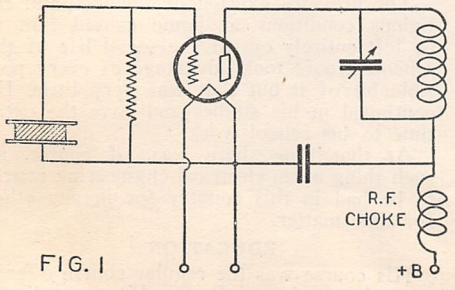


FIG. 1

The crystal is inserted in the grid leg of the oscillator circuit for control of the frequency. Refer to opposite page.

The decision of the Westinghouse Electric and Manufacturing Company to equip its four broadcast stations with crystals for governing the transmitters foreshadows the use of quartz by hundreds of other broadcast stations as a means of minimizing interference. KDKA of East Pittsburgh is already operating a crystal-controlled transmitter and the other stations in the Westinghouse chain, namely, WBZ of Springfield, KYW of Chicago, and KFKX of Hastings, will be equipped similarly in the near future. Experience of the radio engineers of KDKA, under the former method of operation, indicated that a variation in power would cause a shift in the wave-length and if snow or rain clings to the antenna wires, thus producing a sagging effect, a frequency change inevitably follows. Now, by virtue of a mineral about one inch square, this station claims to maintain a constant frequency and, furthermore, to avoid the beat note or howl commonly produced in radio receiving sets.

"When next your radio receiver begins to howl, turn back the tickler," enjoins the engineers of the Westinghouse Electric & Manufacturing Company, "if the howl stops, all well and good—and if it doesn't stop, all well and good also, for you are listening to a swan song.

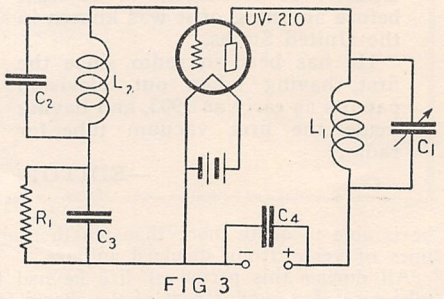


FIG 3

Here is the elementary oscillator circuit for vacuum tubes before the insertion of the crystal.

"If the howl doesn't stop when the tickler is turned back, it is not caused by oscillation of the set, but is due to interference between two stations, at least one of which is off the assigned wave-length. This kind of howl is frequent in receivers today, but is likely to disappear, as a device has been perfected for keeping this wave-length constant and thus holding each station to its assigned place in the broadcast band."

The signal of WGY of Schenectady will also be prevented from straying from its well-defined path in the future, because the General Electric Company claims to be the first broadcast station in the United States to employ the crystal oscillator as a part of its equipment. Subsequently, KGO of Oakland, California, and KOA of Denver, Colorado, will operate as crystal-controlled stations. WGY, for instance, has shown no deviation from its assigned wave-length since introducing the magic piezo-electric effect; and even before this departure, 132 frequency measurements during a period of two years, by the Radio Laboratory of the Bureau of Standards, showed an average deviation of only one-tenth of one per cent. The United States Department of Commerce permits a departure of 2,000 cycles from the assigned frequency and regards a station that holds its frequency within 500 cycles as perfect.

PROPERTIES OF CRYSTAL QUARTZ

Extensive researches into the properties of crystal quartz by the General Electric Company have been productive of interesting conclusions: This mineral, taking the semblance of a frosted window glass, responds to high frequencies or low wave-lengths when very thin. For instance, a 209.9-meter crystal is only two millimeters thick. A 41.88-meter crystal, representing a frequency of 7,160,000 cycles, is four-tenths of a millimeter thick. This implies that specimens of this mineral in the rough, hard as diamond, must be hewn down and then subjected to a slow grinding process until the samples are extremely thin and possibly brittle.

The 209.9-meter wave-length crystal in operation by WGY is completely enclosed, with a micrometer adjustment, in a brass chamber, with provision for introduction into the electric circuit. It functions in the following manner:

When the switch is closed the crystal receives a small voltage across its face and at the next instant the crystal expands and delivers voltage to the circuit at a very definite and unvarying frequency. This action is cumulative and as the voltage is built up the crystal supplies exciting frequency for the master oscillator or crystal-controlled oscillator. This electron tube excites a second tube which has its circuits so proportioned that it picks out only the fifth harmonic of the crystal frequency. In this particular case a 7,160,000-cycle frequency is built up to a sufficiently high value to supply the remaining four amplifiers of the set. In brief, the first tube runs at the fundamental frequency of the crystal, and the remaining tubes, constituting the amplifying unit, amplify the fifth harmonic or transmitting frequency which goes out on the antenna. The constancy of this frequency is as unyielding as the ancient laws of the Medes and Persians. No variation in wave-length takes place even though there may be a change of the filament or plate voltage.

USE OF HARMONICS

Strangely enough, in the use of crystal quartz the engineers of the General Electric Company have capitalized the harmonics which prove so annoying, often times, in radio reception. It is not easily practical to grind this magic mineral to the required thinness for oscillation at a wave-length of 41.88 meters. Therefore, characteristic of engineering ingenuity, a specimen of crystal was ground to the proper size for affording a wave-length of 209.9 meters. Then the

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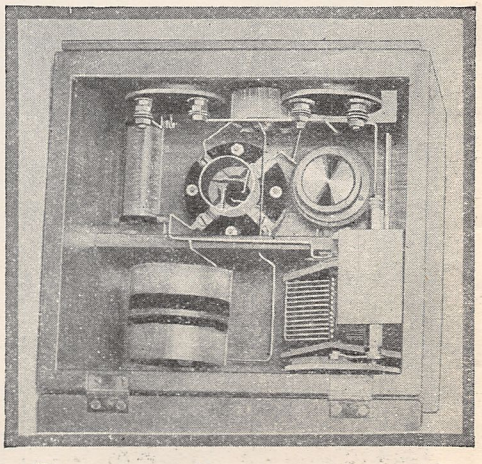
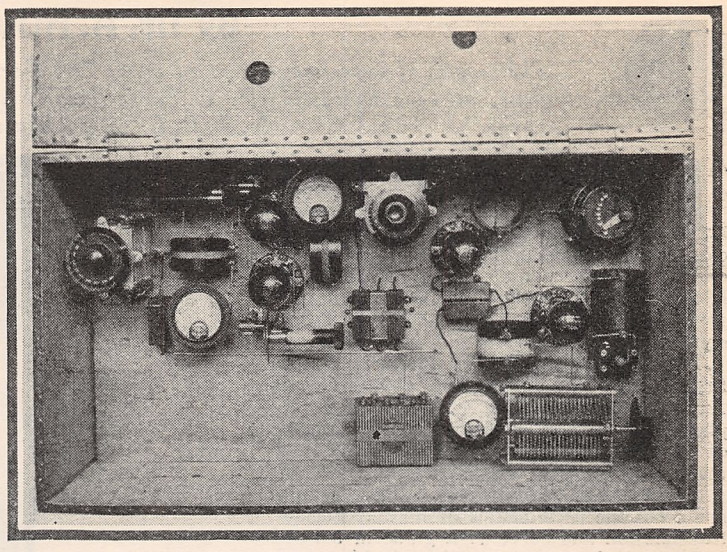


Wave meters may be accurately calibrated with crystals, to one frequency. Above is such a frequency standard. The crystal holder is at the top to the right.

Lengths Of Broadcast Stations

By I. F. BYRNES*

In this discussion, Mr. Byrnes reports accurately the results of experiments with piezo-electric crystals, and gives technical data, both mechanical and electrical, to supplement the article by Mr. Winters that appears on the opposite page.



A small crystal controlled master oscillator is shown in the photograph at the right. All the constants of the circuit must be in exact resonance, else the oscillator will not function.

A NUMBER of applications of quartz crystals, as a means of frequency control for a radio transmitter, are described in this article. It is now well recognized that a high degree of frequency stability must be maintained in our present-day radio stations if we wish to secure reliable transmission with a minimum amount of interference. Quartz crystals permit us to secure this stability with greater precision than any other means now in use on vacuum tube transmitters.

THE PIEZO-ELECTRIC EFFECT

The property of a quartz crystal, which makes it useful in radio work, is known as the piezo-electric effect. "Piezo" is from the Greek and means "to press." If we take a small plate or "slab" of quartz, which has been cut in a suitable manner from the natural crystal, we find that the slab will generate an electro-motive force if pressure is applied between its faces. Conversely, if a voltage from an external source is applied across the faces, the slab will tend to contract along an axis perpendicular to the faces that receive the charge. In order to investigate either of these actions, it is customary to place the quartz slab between electrodes or to cover the faces of the slab with a thin metallic coating which permits connections to be made to the remainder of the circuit.

After this has been done we are then able to produce a third very important effect which may be termed synchronous oscillation of the slab. This is carried out by connecting the crystal across a source of alternating voltage, the frequency of which corresponds to one of the natural frequencies of the slab. Under these conditions the crystal will oscillate in a vigorous manner and will act as an appreciable load on the A.C. supply source. Then, if we change the exciting frequency by a very small amount, we find that the crystal stops oscillating and simply offers a high capacitive reactance to the driving circuit. Before describing in greater detail how this action is utilized to control the frequency of an oscillating circuit, it is of interest to consider how the natural frequencies of the quartz are determined.

In general, a quartz slab will respond most energetically at a frequency corresponding to its thickness, and at one corresponding to its length. For example, a slab 2.015 millimeters thick will oscillate at a frequency of 1430 kilocycles, or 210 meters. A slab twice as thick will operate at approximately one-half this frequency, or 715 kilocycles. Or, we may take the slab which is 2.015 millimeters thick and adjust the circuit so that the longitudinal oscillation is produced, and a much lower frequency (115 kilocycles) is obtained. In this connection it may be remarked that the length which determines the longitudinal oscillation is not the geometrical length of the crystal but is the dimension at right angles to the optical axis (2 axis). For frequencies within the broadcast range or still higher frequencies, it is customary to utilize the "thickness" oscillation of the quartz slab. If, for example, we wish to produce a crystal for WGY's frequency (790 kilocycles) the quartz slab is cut a little thicker than required. It is then ground down carefully until the correct frequency is obtained and the final slab will be about 3.8 millimeters thick. Obviously, great care must be taken during the last grinding operations for, if too much quartz is removed, the slab is rendered useless for the original desired frequency. The ratio of thickness to frequency for quartz is not strictly a constant and while actual measurements of the thickness of the slab are useful for first approximation, final adjustments are made by comparing the frequency with a standard. Roughly, the reciprocal of the thickness (or length) in millimeters times 3000 will give the frequency in kilocycles. Considerable technique and skill are required in order to cut and grind the slabs without impairing their oscillating properties. A 950-kilocycle quartz crystal is shown in Fig. 1. The length of each side is 25.4 millimeters and the thickness is 3.16 millimeters.

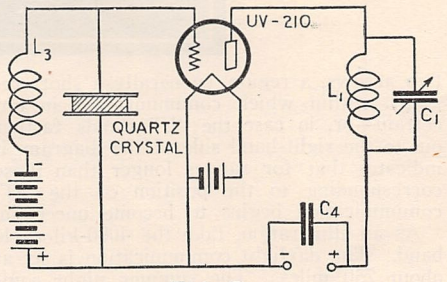


FIG. 5

Here is the elementary circuit upon which all crystal-controlled oscillators are built.

MOUNTING THE CONTROL CRYSTAL

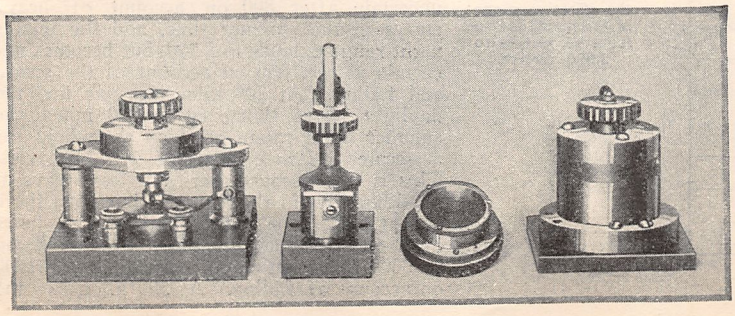
A number of mountings have been devised in order to operate the crystals in various circuits. Four types are shown in Fig. 2. The two "open type" mountings at the left are used chiefly for experimental work when it is desired to make tests on a number of crystals and they permit easy removal of the slabs. The two enclosed mountings are used in more permanent installations and are designed to protect the crystals from dust, moisture, etc. All types are built so that very accurate adjustments of the electrodes can be obtained. This is necessary if we wish to secure the greatest degree of frequency stability and maximum amplitude of oscillation in the radio frequency circuits.

With a suitable oscillator slab and mounting at our disposal, the next step is to use them to control the frequency of a circuit. Consider first a conventional vacuum tube oscillating circuit such as is indicated in Fig. 3. If we properly adjust the parallel circuits L1-C1 and L2-C2, the circuit will oscillate at a frequency determined chiefly by the values of L1, C1, L2 and C2. The condenser C3 and resistor R1 are the usual units provided to hold a negative bias on the grid. C4 is the plate by-pass condenser. Now any change in the values of L1, L2, C1 or C2 will change the oscillation frequency proportionately. Moreover, if we take the precaution to prevent any variations in the four main elements in the circuit we shall next find that variations in plate or filament voltage or the load on the circuit will cause changes in frequency. The latter effects are not necessarily great but they may shift the frequency several hundred cycles. If our tube is an oscillator in a broadcast transmitter the frequency may vary at an audio rate whenever modulation is taking place. If we now connect the quartz crystal in place of L2-C2 we have the circuit shown in Fig. 4. When the crystal mounting is properly adjusted and the plate circuit of the tube is tuned to the crystal frequency, oscillations will take place and considerable circulating current will exist in L1 and C1.

THE ACTION OF THE CIRCUIT

The action of the circuit in Fig. 4 may be described as follows: When plate voltage is applied to the tube the first surge of current builds up a voltage across L1. This is

(*Continued on page* 1069)



One of the most important parts of the crystal-controlled oscillator is the crystal holder. At left are shown four types developed by the General Electric Co. The two at the left are for experimental work while the others are commercial types.

* Radio Engineering Department of General Electric Co.

Navy Investigates Ultra Frequencies

By Dr. A. HOYT TAYLOR

The results of experiments carried on by Dr. Taylor under the auspices of the Navy Department, at the Anacostia, D. C., experimental station, and the recent experiments of the N. R. R. L. are told in the following article.

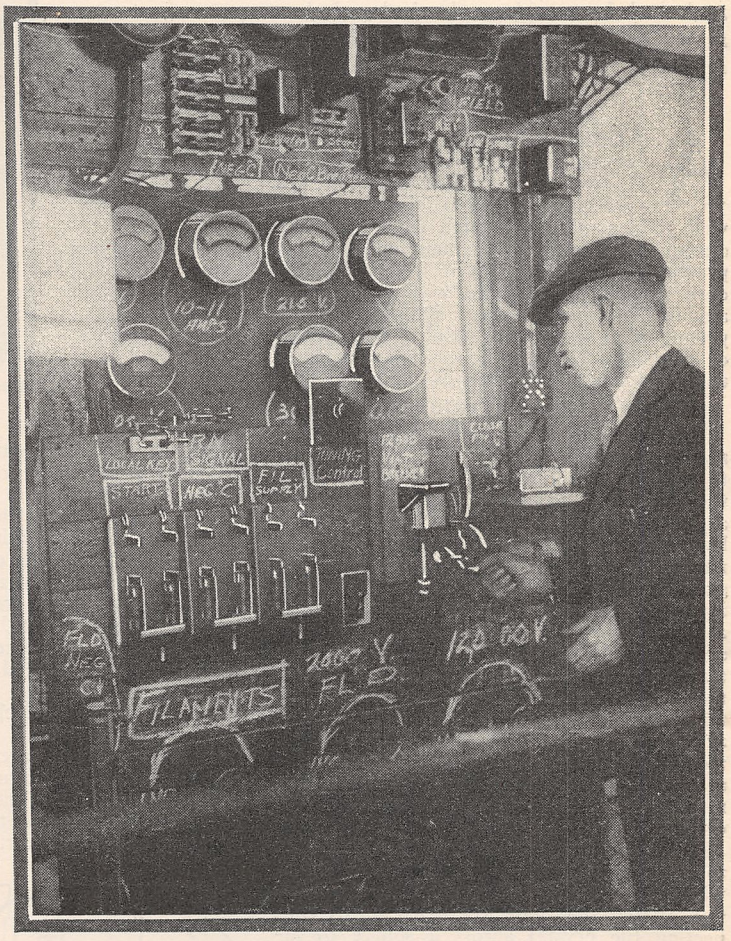
THE object of this article is to present graphically and in systematic form, information which is a summary of the range data for various frequencies, so far as it can be estimated from the extensive experiments carried on by this laboratory, supplemented by considerable information from outside sources which has come in various ways to our knowledge.

Two further objects of the article are, first, to indicate the regions which require further exploration and, second, to show the places where certain transition phenomena of a more or less abrupt character occur as the frequencies are varied from 100 kilocycles to 20,000 kilocycles. This should bring out the peculiarities of high frequency transmission and serve as a guide in a general way in formulating policies looking forward to the possible wider adoption of high frequency communication in the Naval service.

The range chart is based on the following considerations:

(a) Five kilowatts in the antenna.
(b) Average antenna installation.
(c) Communication between points on the same meridian.

The chart is, nevertheless, generally applicable to east and west communication or any communication where there is considerable time difference between the points involved, provided due accounts are taken of this time difference. Nevertheless, it must be admitted at the start that the problem is much more complicated for such a condition, especially where there is a very large number of hours of time difference between two points.



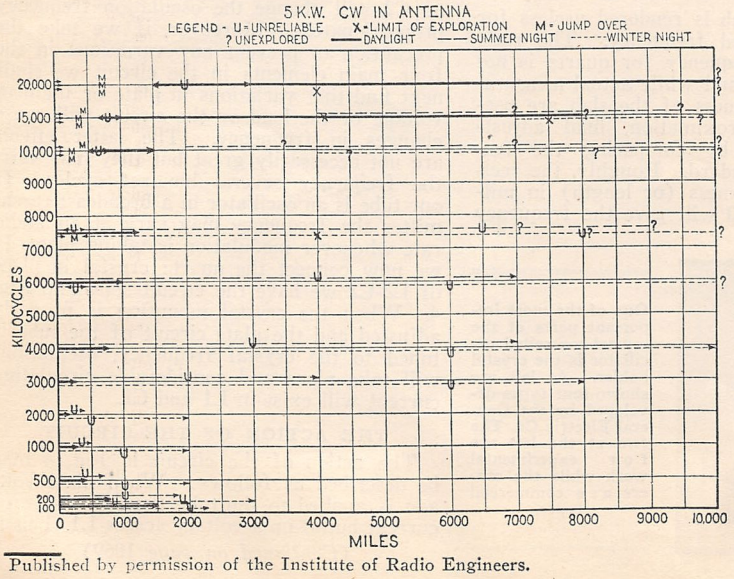
Dr. A. Hoyt Taylor at work in the experimental station at Anacostia, D. C., at one of the short-wave outfits.

WIDE VARIATION IN NIGHT RANGE

There is, of course, considerable difference between the daylight ranges, summer and winter, but not anything like the differences which occur in the night range. Therefore, the line on the chart indicating daylight ranges must be considered as average ranges, summer and winter, but for the night range, the lower dotted line indicates the winter night range and the upper dotted line indicates summer night range.

A cross entered on the line indicates the limit of actual exploration and the extension of the line beyond the cross indicates the probable range. A "V" entered on the line, indicates, if bounded on right and left by two arrows, a region (generally a short region) within which communication in uncertain—or, in case the "U" stands farther out to the right-hand side of the diagram, it indicates that for ranges longer than those corresponding to the position of the "U" communication begins to become uncertain.

As an illustration, take the 4000-kilocycle band. The daylight communication is set at about 750 miles. The summer night communication is at about 7,000, but uncertain after 3,000. The winter night communication extends to 10,000 miles but is subject to some uncertainty after 6,000. Another instance of the use of the "U" is shown in the 6,000 kilocycle band in which there is an uncertain region between 150 and 400 miles beyond which the range again becomes certain and extends to 10,000 miles (probably) but is uncertain after 7,000. That is, this frequency has two regions of uncertainty; one of close regions and the other at very distant regions. The use of the question mark ("?") is for the purpose of indicating unexplored regions. The use of the "M" on the diagram means that the radiation "skips over" or "misses" entirely the region indicated; therefore the "M" is always bounded by arrows right and left. An instance of this is the 15,000 kilocycle band which skips over the region from 75 miles to 700.



This chart shows the effective range of transmission from 15 meters to 3,000 meters.

COMPARISON OF PHENOMENA AT VARIOUS FREQUENCIES

Starting with 100 kilocycles, whose ranges are fairly well known from the performance of a transmitter similar to the Ship TL sets, we see that the daylight range is about 1,200 miles, the summer night range 2,000, but uncertain after 800 on account of heavy strays in the summer time, and the winter night range extends to 2,500, but becomes uncertain after 2,000 on account of the strays and fading. At 200 kilocycles, we find the daylight range shortened to 800 miles, the summer night range good on the whole for a greater distance than the 100 kilocycles. This is true because there are less strays at 200 kilocycles in the summer time than there are at 100. The winter night range, however, overlaps that for 100 kilocycles, going to 3000 miles, although uncertain after 1800 on account of fading. At 500 kilocycles the

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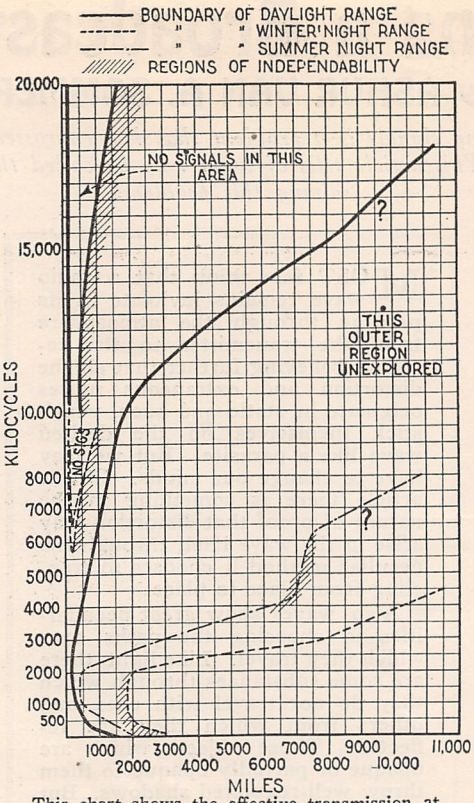
daylight range is still further shortened and the summer night range is not certain for any greater distance than the daylight range, but the winter night range is certain for much greater distance and the extreme winter night limit (2,000 miles) is more than three times the normal daylight range. At 1,000 kilocycles we see the daylight range still further shortened but the night range considerably exceeding it even in the winter, whereas in the winter the extreme ranges are very greatly in excess of the normal daylight range, with however, about half of the winter night range in the region of uncertainty. It should be stated at this point that the table is based entirely on C.W. telegraphic communication. At 2,000 kilocycles the daylight range is cut to 125 miles and the summer night range is not a great deal better; but the winter night range is enormously greater than the daylight range, with however, a great region of uncertainty in the winter night range, due to fading. The performance here is based on the Fleet's report of the model TV transmitters built by this laboratory, and tested out on the *California* and *Tennessee*. It is also based on amateur data to a certain extent.

Between 2,000 and 3,000 kilocycles, the phenomenon shows a rather abrupt change. At 3,000 kilocycles the daylight range is much greater than at 2,000, which is a reversal of ordinary behavior at lower frequencies. The summer night range is enormously extended and the winter night range still more so. We see that the reliable night ranges for summer jump to 2,000 miles and as a matter of fact this figure is probably considerably underestimated. It is, however, desired to make the chart conservative, at least in its application to the higher frequencies. The night ranges in the winter time, however, are certain up to 6,000 miles. Comparing 3,000 kilocycles with 100 kilocycles, we find the 100 kcs. excels in daylight range but that the 3,000 kilocycles greatly excels in possible night ranges. At 4,000 kilocycles



This chart shows the effective transmission at various wave-lengths, redrawn from the chart on the opposite page for purposes of interpretation.

we see the daylight range extended to 750 miles, the summer night range certain to 3,000, with a possible night range to 7,000; while the winter night range is certain to 6,000 with possib'e ranges to 10,000. At 6,000 kilocycles the daylight range extends to 1,000 miles and the summer night range to 4,000 with possible ranges to 7,000, whereas the winter night range probably goes to 10,000 but has not been fully explored. We may consider it uncertain at least after 7,000.

A new and interesting phenomenon makes its presence felt for the first time in the diagram regarding an uncertain period within short distances during the winter night transmission; namely, between 150 and 400 miles. In the next line on the diagram for 7,500 kilocycles, the daylight range has been further extended to 1,200 miles, thus nearly equalling the 100 kilocycle transmitter but an uncertain region not far from the transmitter has been introduced between 100 and 350 miles during the summer night range and a skip, or entirely-missed region occurs in winter night ranges between 100 and 350 miles. This frequency has been explored to 4,000 miles, but it is believed that it will carry very much further. We may say that it is uncertain, however, after 8,000 and probably will carry to 10,000 on the winter nights. At 10,000 kilocycles we see that the "jump" or "miss" occurs both summer and winter and also by daylight but the daylight jump is only about 500 miles, whereas the summer night jump is very great indeed. Very little exploration has been made of this frequency for nocturnal transmission but there is good reason to suspect that the summer night jump is in the neighborhood of 2,000 miles and the winter night jump possibly 4,000 miles. There is also good reason to believe that frequencies not far from 10,000 kilocycles can be successfully used for extreme night ranges. (Note Samoa's successful reception and steady intensity of tests from Schenectady, N. Y., on tests of 35 meters at night.)

Fifteen thousand kilocycles: Here the daylight jump is increased to between 600 and 700 miles and an uncertain region follows this to 1,000 miles but beyond this, so far as the exploration has gone (4,000 miles), results are excellent. It is impossible to say what the daylight range will come to beyond

(*Continued on page* 1086)

RADIO SET DIRECTORY

RADIO has now arrived at the stage where receiving sets have become stabilized to a very high degree. Inasmuch as there is continuous discussion as to various features of sets produced in the United States, RADIO NEWS has taken the initiative to present, month by month, a complete picture of the entire set industry.

In presenting the various sets in a directory of this kind, it is naturally only possible to touch the high points, and we have therefore listed all outfits under a simple classification that will, we hope, be of great service to the public, as well as to the trade. We have attempted in this directory to list every set manufactured in this country, and although we have written a number of letters to all manufacturers, not all have replied. In order to make the directory complete, all sets manufactured by any one manufacturer listed have been included.

The Directory will be kept up to date, month to month. All manufacturers are invited to send monthly corrections as to the various features of the sets which they produce.

AMERICAN BOSCH MAGNETO CORP.
Springfield, Mass.
Trade Name: Amborola
Batteries: Storage "A" —Dry "B"
Antenna: Indoor or outdoor
Loud Speaker: Separate
Controls: None (two internal indicators used)
List Price: $145.00

PLAZA MUSIC CO.,
10 West 20th St.,
New York City
Trade Name: Fine-Arts R-1
Circuit: Tuned radio frequency
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Separate
Controls: Three
List Price: $35.00

* * *

Trade Name: Fine-Arts R-2
Circuit: Tuned radio frequency
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Built-in
Controls: Three
List Price: $50.00

* * *

Trade Name: Fine-Arts R-3
Circuit: Tuned radio frequency
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Built-in
Controls: Three
List Price: $85.00

* * *

Trade Name: Fine-Arts R-4
Circuit: Tuned radio frequency
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Built-in
Controls: Three
List Price: $125.00

* * *

Trade Name: Fine-Arts R-5
Circuit: Tuned radio frequency
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Built-in
Controls: Three

A CORRECTION

In the November, 1925, issue of RADIO NEWS, in the columns of the Radio Set Directory, the price of the Model Six Receiver, manufactured by the Colin B. Kennedy Corporation, was listed in error as $25.00. The price of this receiver is $85.00.

The Colin B. Kennedy Corporation also announces a reduction in the price of their Model Fifteen Receiver from $120.00 to $110.00 and of their Model Twenty Receiver from $90.00 to $80.00.

List Price: $150.00

POWEROLA RADIO CORP.,
1845 Broadway,
New York City
Trade Name: Powerola C-3
Circuit: Tuned radio frequency
Batteries: Adapted for A.C. or D.C. power circuits
Antenna: Indoor or outdoor
Loud Speaker: Separate
Controls: Three
List Price: For D.C. $115, for A.C. $165.00

* * *

Trade Name: Powerola C-3 Electrical Panel
Circuit: Tuned radio frequency
Batteries: Adapted for A.C. or D.C. power circuits
Antenna: Indoor or outdoor
Loud Speaker: Separate
Controls: Three
List Price: For D.C. $100, for A.C. $150.00

* * *

Trade Name: C-3 De Lux 114
Circuit: Tuned radio frequency
Batteries: Adapted for A.C. or D.C. power circuits
Antenna: Indoor or outdoor
Loud Speaker: Separate
Controls: Three
List Price: For D.C. $280, for A.C. $320. Complete except for 5 tubes

* * *

Trade Name: Powerola C-3 Highboy 113
Circuit: Tuned radio frequency
Batteries: Adapted for A.C. or D.C. power circuits
Antenna: Indoor or outdoor
Loud Speaker: Separate
Controls: Three
List Price: For D.C. $230, for A.C. $280. Complete except for 5 tubes

Trade Name: Powerola C-3 Highboy 111
Circuit: Tuned radio frequency
Batteries: Adapted for A.C. or D.C. power circuits
Antenna: Indoor or outdoor
Loud Speaker: Separate
Controls: Three
List Price: For D.C. $245, for A.C. $295. Complete except for 5 tubes

* * *

Trade Name: Powerola C-3 Highboy 110
Circuit: Tuned radio frequency
Batteries: Adapted for A.C. or D.C. power circuits
Antenna: Indoor or outdoor
Loud Speaker: Separate
Controls: Three
List Price: For D.C. $245, for A.C. $295. Complete except for 5 tubes

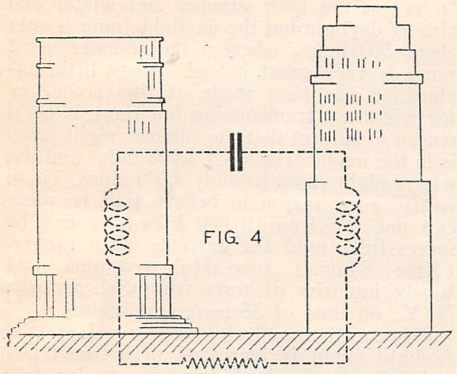
(*To be continued*)

Unraveling a Broadcast Enigma

By ASHUR VAN A. SOMMERS

The phenomenon of fading signals is a problem that has engrossed the attention of investigators for many years. This article tells of what may be called the first decided advance in solving this problem.

THE problem of fading has always absorbed a great deal of attention from engineers and amateurs the country over. The American Radio Relay League, working in conjunction with the Bureau of Standards, has amassed a great amount of valuable data from several series of tests held within the last few years. It has remained for engineers of the American Telephone and Telegraph Company, however, to analyze and co-ordinate data on fading and to give the first well-founded theory of its basic causes.



The steel framework, metal pipes, etc., in and between tall buildings may form an oscillating system as shown in this illustration.

Incidentally, the work done by the American Telephone and Telegraph Company's engineers has uncovered, as a corrolary to the main problem, a mass of equally important data on distortion. Until recently scientists have supposed that all distortion in radio communication occurred either in the transmitting or in the receiving apparatus itself. The ether has been looked upon as a conducting medium so flexible that any impulse impressed upon it at the transmitting antenna would reach the receiving antenna with its original form unchanged in relative contour. The recent efforts to refine the tone of broadcast speech and music have disclosed, however, a form of distortion that takes place while the radio waves are passing from the transmitter to the receiver, and the fading tests have resulted in a very tenable theory of the cause of this "en route" distortion.

MOST fans think that a radio wave remains inviolate in its passage through the atmosphere from the transmitter to the receiver, believing further that all the distortion and extraneous noises originate in static and such, which stick themselves on the desired wave like a parasite. But we may have to change our minds. In this article there is something in the nature of proof that distortion may arise in the wave itself through the peculiar method it chooses in traveling from place to place.

Also, waves show great peculiarities in choosing the paths over which they travel. Like light, there are some substances through which they do not travel with ease, and others from which they are reflected. Those objects which are opaque or partially opaque to them throw well-regulated shadows. But these shadows fall in very peculiar places. The article tells of several of these phenomena.

At a meeting of the Institute of Radio Engineers, held in New York City on November 4, 1925, Dr. Ralph Bown presented a paper outlining the experiments, data and deductions of the research and development department of the American Telephone and Telegraph Company in attacking the twin problems of fading and distortion. The paper was prepared by Dr. Bown working in conjunction with Messrs. De Loss K. Martin and Ralph K. Potter. It covered experiments that have been made over a period of more than a year past. Some of the conclusions are little more than statements of conditions that have been known to exist for several years, such as the fact that all frequencies do not fade simultaneously, and that some stations will be free from fading at precisely the same time and under the same conditions that give rise to bad fading in others. But much new data has been presented and, what is far more important, the phenomena that have been common but baffling for many years are at last explained in a thesis that is at once complete, scholarly and practical.

The heart of the whole matter hinges upon the realization that the ether lying between the transmitting and receiving antennae is not the perfect carrying medium for electromagnetic waves that it has been supposed. Extraneous objects of all kinds have the power to influence the ether waves by reflection, refraction or absorption, partial or complete.

This deduction was the result of tests made with several field stations in the vicinity of New York City. Transmitting station 2XB, the experimental transmitter at WEAF, was used to supply pure sine waves for the tests, in order that distortion as well as fading might be checked. Early experiments resulted in a mass of apparently meaningless data. It was found that the signals at one receiving station would be comparatively steady at the same time that severe fading was noticed at another. Not only were dead spots and live spots discovered and charted, but also these areas were found to shift slowly for no apparent reason. Oscillograph records showed that in many instances the original pure sine wave underwent a change that could in no way be accounted for by the mere process of fading.

In order to remove entirely the possibility of fading at the transmitting station itself, due to swinging antenna, fluctuations in power supply, etc., the transmitter was driven by a piezo-electric crystal which kept the master oscillator at an absolutely uniform frequency. After this precaution was taken, any fading or distortion that occurred could safely be located as somewhere in the space intervening between the transmitter and the field station.

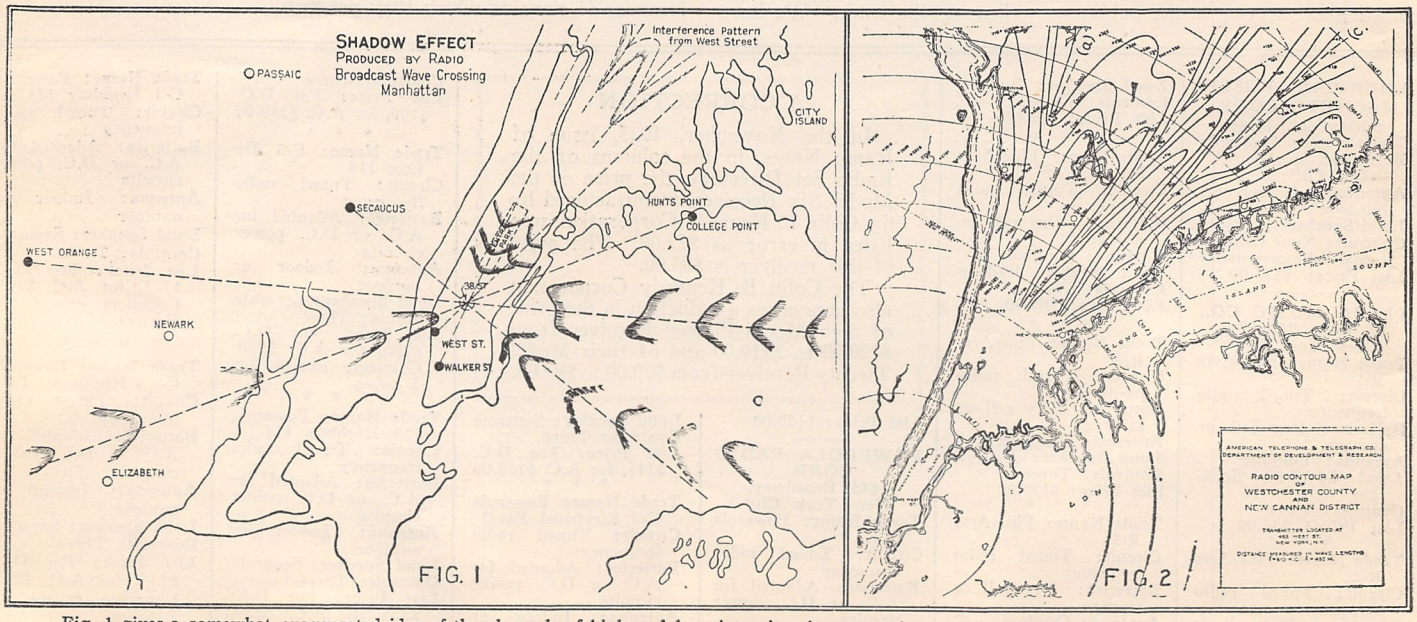


Fig. 1 gives a somewhat exaggerated idea of the channels of high and low intensity that occur in a wave radiated outward from lower New York. Fig. 2 is a more accurate map of the wave interference conditions in Westchester County. Note that the distances are measured in wave-lengths.

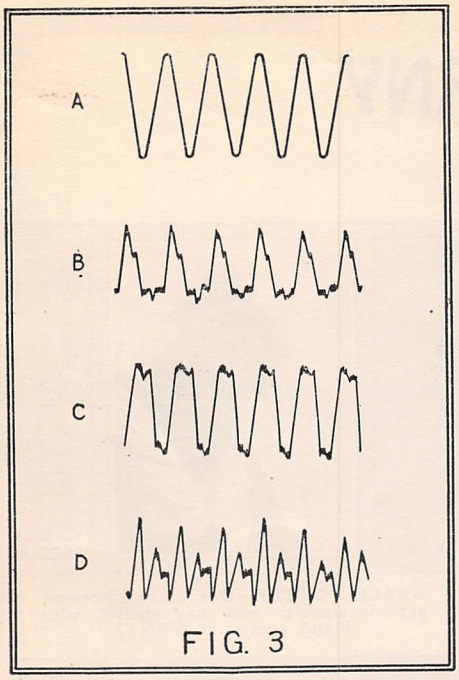


FIG. 3

Oscillograms of the original pure sine wave as transmitted, and various forms of distortion that occurred before reception.

Quality distortion, it had been supposed, occurs only at night, and only at great distances from the transmitter. These tests have disclosed, however, that quality distortion can occur within a short distance of the broadcast station, and in at least one case it was definitely shown that it can occur in daylight as well as at night. Furthermore, it was noted as significant that distortion is always accompanied by fading, although the reverse is not necessarily true.

The most startling early instance of definite, permanent dead areas came when it was discovered that, at a point near New Canaan, Connecticut, signals from 2XB were much more feeble and more prone to distortion than signals from 2XY, the American Telephone and Telegraph experimental station at 24 Walker Street, although the former station has ten times the power of the latter. As a result of this discovery, a field survey was made by Mr. G. D. Gillet, and the data obtained was plotted on a map of the district in question. This, when completed, showed a definite pattern of lines of high and low intensity radiating outward from Manhattan Island like the arms of a mythical but rather sinister octopus. These regions of minimum intensity extend in most cases in approximately straight lines, as is pictured in Fig. 1.

To anyone famliar with the phenomena of optics, this pattern of peaks and valleys of energy radiating roughly from a point near the transmitter suggests an action similar to interference bands that occur in light waves. Consequently, lines were drawn down the most pronounced valleys, with the assumption that the source of interference would be found at their intersections. These lines, as can be seen in Fig. 2, came together at approximately 38th Street and Sixth Avenue, very near the center of the tall building district of central Manhattan, leaving little doubt that the great steel-frame structures were, in some measure at least, the cause of the interference. With this approximate assumption to work from, a more accurate survey was made, which corroborated and verified the first one. An examination of Fig. 2 will give some idea of the results of the more extensive survey that established beyond any reasonable doubt the truth of the foregoing assumption.

The next problem, after the source of interference had been located, was to study the basic ways in which the interference was brought about. The most probable causes seemed to be refraction and absorption. The latter theory hinged upon the probability that two adjacent buildings form an oscillating system, due to the ground connection between masses of water pipes and electrical wiring, and to the capacitative coupling between their respective steel frames. Such a system or series of systems would absorb and dissipate a portion of the wave front in quite the same manner as would an antenna. In consequence, a certain part of the wave front would travel on in a weaker condition than the rest, casting a shadow very similar to the shadows patterned in Fig. 1. But further experiments showed that this theory can be made to account for not more than a small part of the trouble. If the cause of the "light-and-shadow" pattern were nothing more than absorption of this kind, the wave front would still travel outward with the *proportionate* intensity of all parts remaining the same. But this was not found to be the case. As the distance from New York increased, it was found that the signals in the "dead" channels decreased in relative strength much more

(*Continued on page* 1075)

THE INVENTIONS OF REGINALD A. FESSENDEN

Due to the continued illness of Prof. Reginald A. Fessenden, we are sorry to announce that the continuance of his articles under the above title will again be postponed. Let us hope that Prof. Fessenden's recovery will be rapid, both for his own sake and for the sake of the many who we know are impatiently awaiting the remainder of these articles.

Secretary Hoover Opens Radio Conference

Herewith is a verbatim report of the address with which Secretary of Commerce Hoover opened the recent radio convention.

THIS is the fourth annual occasion upon which I have had the pleasure of calling together the National Radio Conference for consultation with the Department of Commerce in the solution of the ever-new problems which have developed in the growth of this astonishing industry.

We have had great reason to be proud of the results of these conferences. From them have been established principles upon which our country has led the world in the development of this service. We have accomplished this by a large measure of self-government in an art and industry of unheard-of complexity, not only in its technical phases, but in its relation both to the Government and the public. Four years ago we were dealing with a scientific toy, today we are dealing with a vital force in American life. We are, I believe, bringing this lusty child out of its swaddling clothes without any infant diseases. We have not only developed, in the conferences, traffic systems by which a vastly increasing number of messages are kept upon the air without destroying each other, but we have done much to establish the ethics of public service and the response of public confidence.

Some of our major decisions of policy have been of far-reaching importance and have justified themselves a thousand fold. The decisions that the public, through the Government, must retain the ownership of the channels through the air with just as zealous a care for open competition as we retain public ownership of our navigation channels has given freedom and development in service that would have otherwise been lost in private monopolies. The decision that we should not imitate some of our foreign colleagues with governmentally controlled broadcasting supported by a tax upon the listener has secured for us a far greater variety of programs and excellence in service free of cost to the listener. This decision has avoided the pitfalls of political, religious and social conflicts in the use of speech over the radio which no government could solve—it has preserved free speech to this medium.

While we have reason to congratulate ourselves on the success of past conferences and on the results that have come from them, we still have difficulties to face and overcome. But before I come to a discussion of them it seems proper to describe some of the progress in the various branches of radio during the twelve months past. We shall thus logically arrive at existing conditions and present problems which now press for solution.

Secretary Hoover, who, it is rumored, will occupy a position in radio similar to that of Mr. Hays in the cinema industry, takes a few moments off to listen in.

TELEGRAPHIC RADIO

The rapid extension in the international field by American radio telegraph companies, which has already given us a dominant position, has continued during the past year. Public service has been inaugurated with Colombia, Honduras, Costa Rica and Nica-

(*Continued on page* 1042)

How to Follow WRNY

By DR. CHAS. D. ISAACSON

Further notes are given below on the novel plan being carried out by the program director of Station WRNY.

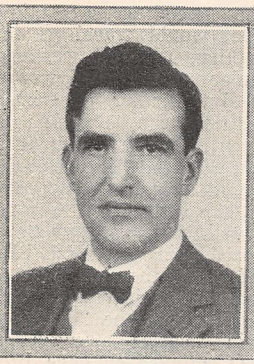
NO MATTER where you are you can pick up WRNY and work right into its developments any day, any hour. Of course you can look into the daily newspapers and find what is happening if there are last-minute changes, but for the whole general plan all you need do is to look into WRNY's big prospectus of the general broadcast program and special features, and it is the easiest thing in the world.

In the center of the book is an outline of any two weeks, just where any feature appears in a two-week plan. Thus, let us say it is Tuesday, you locate Tuesday, say 8 o'clock, and you find that the Hampson Light Opera Company is giving, let us say, "The Tales of Hoffman," you know you are then in week one, and from that moment forth you can follow WRNY that week into the second week and back again into the first week, just like a great big race track that is a circle—if you start at one point, you go around and come back to it. Or, if instead of the Gordon Hampson Light Opera Company, the Mme. Andres Parker Singers are appearing at that time you will know that you are in the second week of the WRNY standard schedule and you will begin there and follow the rest of the week and back into the first. Thus you can pick up WRNY at any time and move in unison and understanding with the program department and all of the staff of WRNY.

USING THE WRNY PROSPECTUS

But there is something more than that that you can do. Let us return to the idea that this is Tuesday, 8 o'clock, and that the Gordon Hampson Light Opera Company is appearing. You turn to the back of your big program book to the general index and you find under the heading of the Gordon Hampson Light Opera Company reference to page 7. You will discover who is in the cast, information about the singers and the conductor and you locate where you are in the repertoire which they are singing so that you can fit immediately into that individual company's development. You know what you have missed and what you are still to hear and you are immediately *en rapport* with the whole spirit of that organization.

LENI STENGEL—The continental comedian sings songs in his own inimitable manner.



ALFRED McCANN—He is unquestionably the world's foremost authority on food. Alfred McCann at WRNY.

RITA MAGINOT—Gives the series of A to Z Piano Classics and also directs "Rita's Kiddy Music Party."

PIERRE REMINGTON—One of Am ri-ca's finest light opera bassos. Pierre Remington is a member of the Gordon Hampson Light Opera Company.

BERNSTEIN SISTERS TRIO—Minna, Deborah and Selma, are musicians of remarkable ability.

GRACE POTTER—One of our foremost psychoanalysists, who has studied with Freud, appears at WRNY.

MAJ. ATKINSON—Here is the indomitable world traveler, Major Dent Atyinson of WRNY.

MRS. PEMBERTON—Mrs. Brock Pemberton, wife of the theatrical producer and designer of the costumes for "The Green Hat" speaks on theatre costumes.

BEN BERNIE—The maestro, as he is called, leads one of the most popular orchestras in the world.

KATHRYN BEHNKE—This is the "Lullaby Lady," Kathryn Behnke.

RADIO ART THEATRE—A stock company devoted to the classics. In the picture are Miss Bellfato, Miss Perry, Mr. Newmark, Mr. Luden, Mr. Pratt and Miss Sonergaard.

HARVEY WILEY CORBETT—The architect of the new National Masonic Memorial to Washington is the director of architecture at WRNY.

NICHOLAS ORLANDO — He leads the Roosevelt Concert Orchestra three times a week at WRNY.

ROSE DREEBEN — The poet-peasant, sings the songs of the people in all their native simplicity.

JOHN MARTIN—The most beloved friend of children, directs WRNY's fairy tale period.

CUGAT—The Spanish violinist, Xavier Cugat, besides being one of our best violinists, is a capable and gifted cartoonist.

Now let us suppose that you are particularly fond of light opera and you want to know whenever light opera companies appear. You refer again to the general index at the back of the book and find that heading which gives you all of the individual companies and singers interested in light opera. You turn all these pages and find out how much light opera is going to be given you in the course of six months. For this new book, which is 64 pages, the size of a magazine, gives you the whole program of WRNY for a complete six months' period.

It gives you pictures of all of your favorite people, it provides you with the story of their careers and the plan of their offering to you at WRNY. It is extremely interesting and valuable and many hundreds will be constantly referring to this book, which will be as fixed an attachment to their radio receiving sets as the dials. It is a compendium of information, a complete curriculum of what you are going to hear. This new book and this new plan of WRNY takes away all of the haphazardness and vagueness of original broadcast program making. It means that WRNY is promising a definite policy, that, allied with WRNY, is a fixed feature and that everything which happens at WRNY is moving along a definite channel of thought.

The book is being distributed now and I suppose it will not be long before several thousands of people will be asking for copies, after we have run out of the first edition and have to reprint. RADIO NEWS has been very generous and has agreed to send this volume out to you absolutely without charge.

This book and all that is happening here at WRNY is opening a great new field for radio. It does not seem to me possible, as some have suggested, that with the broadcasting of grand opera in the sort of manner that we bring it, in little tastes, people are no longer going to the opera—quite the reverse. I believe that *because* we are giving the stories of the opera, the principal melodies of the opera, that you, the listener, will find it necessary to go to the real performance. I am frank when I say to you that no radio performance could satisfy me, no matter how fine the artists, the performance, the radio set. I want to see the theatre itself, the stage, the setting, the actual living performance. There is, on the other hand, the individual who listens to the broadcasting of a game, baseball, football. That could never satisfy or be a substitute for the actual game itself.

For myself and for WRNY, I repeat again and again that we want to make more people go to theatre, attend the opera and concerts, witness games, read books, view art exhibits, hear lectures and live with the actuality. Broadcasting anything is merely an impetus to the real thing, if it is worth while.

So this new book and new plan of WRNY enables the listener to pick any field of human endeavor in entertainment and education and acquire enough knowledge and taste for any individual feature to want that feature in actuality.

Here one can find the entrance into some unknown field. Let us take architecture. Who is interested in architecture besides the architect? Very few, and yet all about us are great buildings. They belong to us as much as to those who own them. Here is Harvey Wiley Corbett, one of the world's greatest architects, to tell us about architecture. Mr. Corbett speaks for five minutes a week only—and a new field is opened to us.

I remember that Helen Meany, champion diver, came over; that Resta Crowell gave us a charming presentation of "The Second Mrs. Tanqueray," and I recall the many visits to other lands which we made with J. Van Cleft Cooper and the Volga Trio.

In grand opera, the DeMacchi Opera Company gave us "Rigoletto." The Taverna Opera Company gave us "Cavallera" and "Il Trovatore" and the Louis Aschenfelder Company "Manon" and "La Boheme."

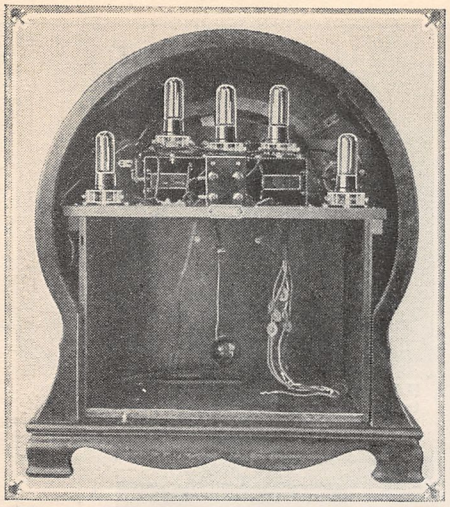
Then there were those gatherings on Tuesday evenings, known as "Up and Down Broadway." We had the whole cast of "No, No, Nanette," with the principles, Louise Groody and Charles Winninger, Blanche Ring and Otto Harback were also here. The

(*Continued on page* 1024)

New Developments in Radio Receivers

By G. C. B. ROWE

In this article is an interesting description of two receivers that are forerunners of their particular types.



This photograph shows the interior of a receiver that has generous space for batteries beneath the radio apparatus.

WITHIN the last few years science in general has stridden forward with steps that would do credit to the "seven-league boots" that fascinated us as children. Thanks to the tireless efforts of many patient workers those same tales that were so real and yet improbable, are things of reality today. It is needless to reiterate what these manifold wonders are, because daily we use some of them and think nothing of it. However, because of its recent popularity we are more inclined to appreciate the advances that have been made in radio.

As recently as two years ago little thought was given by the radio set constructor to the aesthetic side, and if a set had more controls than were necessary to operate a battleship, it made little difference as long as some favorite station could be picked up with fair volume. Of course, I am speaking now of the outward appearance of the cabinet, for within, as long as copper has been used for connection wires, electrical efficiency was the watch-word and neatness was therefore paramount. However, since radio has become so firmly established as a national pastime, the demand for more decorative cabinets and receivers that could be operated by anyone from grandma down to the baby has been answered by the multitude of attractive receivers that have appeared on the market within the last few months.

Formerly radio engineers were chiefly concerned with the circuits and a "new" receiver was one in which there was incorporated a new circuit or a variation of an old one. Today circuits have become more or less standardized and it is rarely that a new principle is announced. Naturally, there are "new" circuits talked of, but it is in the mechanical features in conjunction with the receiver circuit that the majority of fans are interested today.

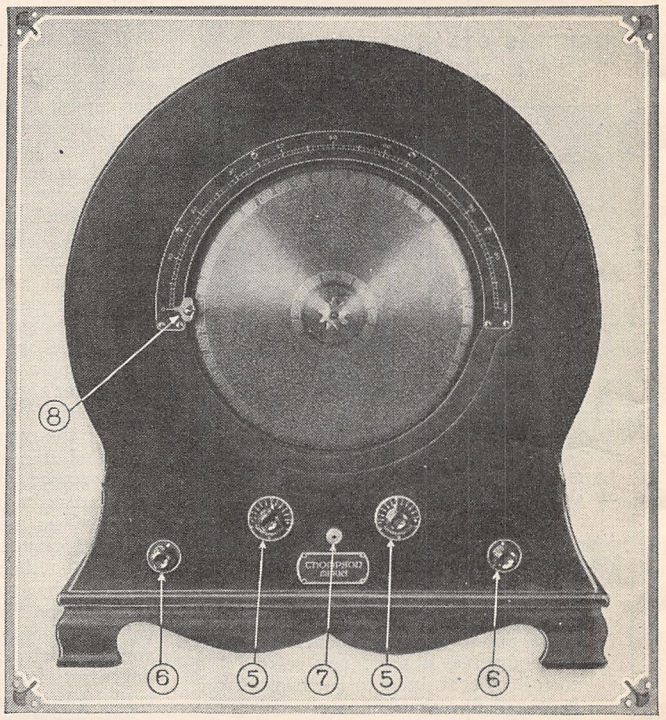
An excellent combination of a standard circuit with an innovation in mechanical design is shown in the photographs on this page. The neutrodyne principle is admitted to be one of the best for all-around reception and it is this principle that is utilized in this receiver. There was one objection, however, to the neutrodyne and this was that there were three dials to adjust when tuning in a station. This objection has been eliminated in this receiver, as there is but one tuning control, which is the small handle that slides around the periphery of the cone loud speaker.

MECHANICAL CONSTRUCTION

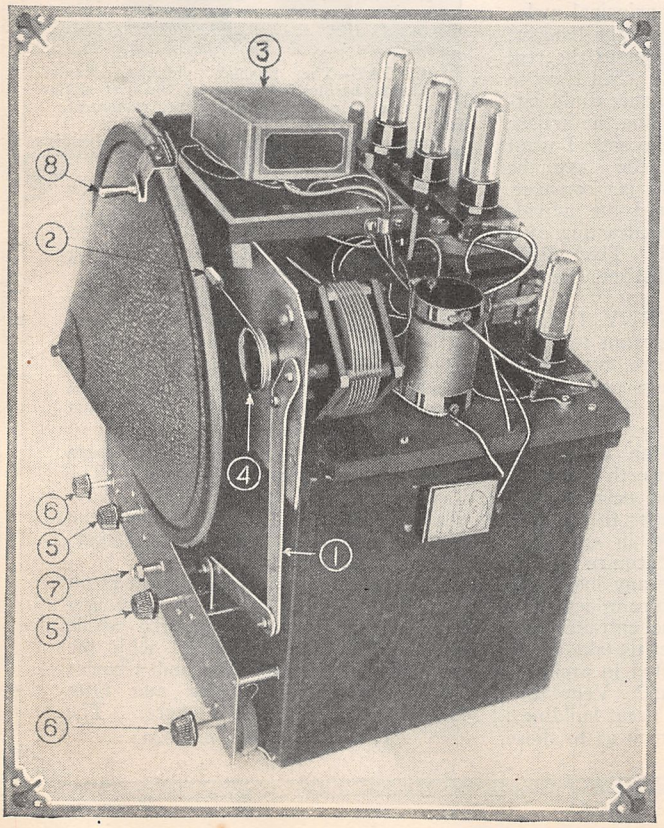
This small handle operates a system of pulleys that in turn operates the three variable condensers. As can be seen in the photograph of the apparatus removed from the cabinet, these pulleys are on the shafts of the condensers and the cables are of piano wire that is tightened in place by small turnbuckles. Because of this method of operation, there is slight chance of the condensers failing to function as they are intended.

The system of levers, of which there is one for each condenser, is used for varying the position of the stator plates of the variable condensers, *i. e.*, the condenser as a whole can be varied through a few degrees. This elaborate lever system may, on first thought, seem unnecessary and complicated in operation, but this is entirely false. This variation of the stator plates is for the equalization of any irregularities in the radio frequency transformer windings. When these plates are once adjusted there is no need for disturbing them until the set is used under other conditions.

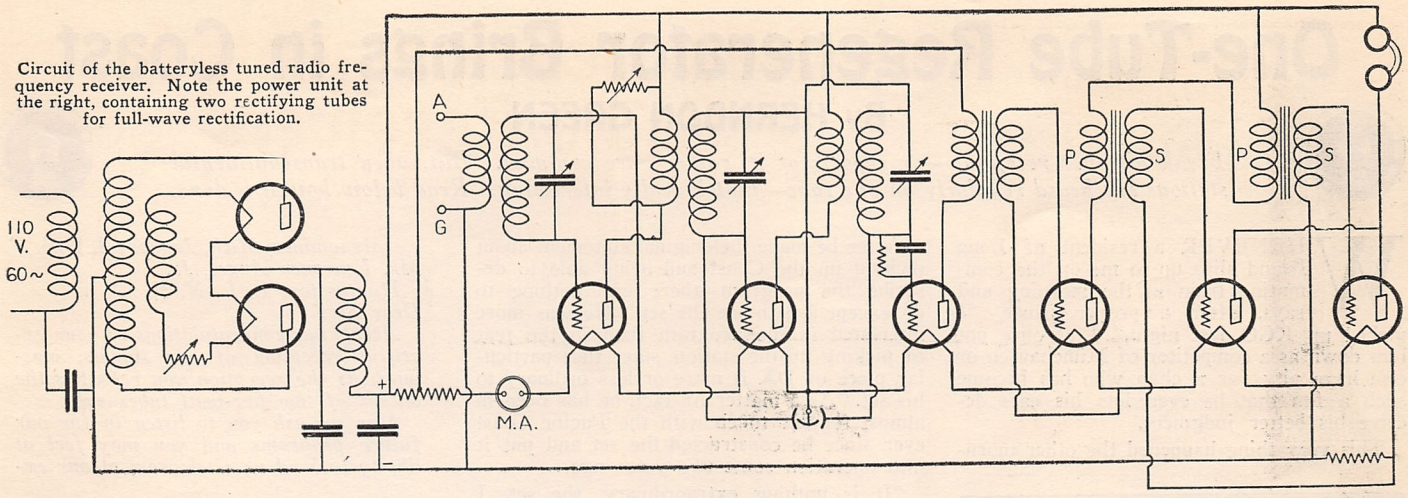
The circuit is designed for use with the new UX-199 tubes and the batteries that supply the power for the five tubes fit in the compartment under the shelf on which is placed the apparatus. The socket of the detector tube is supported on a vibration-proof base of sponge rubber, in order to eliminate any undesirable microphonic noises. The battery leads have different-colored insulations so that the wrong voltages will not be applied to the vacuum tubes. The dimensions of the cabinet are as follows: over-all diameter, 18 inches; height, 22½ inches and



The cone loud speaker is part of the front of this receiver. The numbers correspond to those shown on the left. Stations can be logged by recording the numbers on the scale indicated by tuning control, 8. *Photos courtesy of the R. E. Thompson Mfg. Co.*

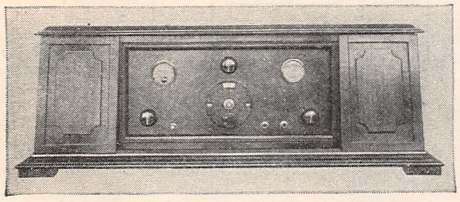


The apparatus removed from the cabinet. At 1 is shown the system of levers for compensating the capacity of the coils; 2 is the connecting cable of piano wire; 3, "C" battery; 4, pulley; 5, compensator controls; 6, rheostats; 7, filament lock switch; 8, tuning control lever.



Circuit of the batteryless tuned radio frequency receiver. Note the power unit at the right, containing two rectifying tubes for full-wave rectification.

the depth, 12 inches. The two outside dials on the front of the cabinet are the rheostat controls and, as these require little adjustment after being set, the tuning can be said to be done with the single control. The stations can be logged by means of the scale



Notice in this front panel view the two meters for checking the rectified current.

on the front of the cabinet around the top of the loud speaker.

THE CIRCUIT

As has been mentioned above, the circuit of this receiver is a neutrodyne with one or two variations. It can be seen from inspection of the wiring diagram that the primary of the antenna coupler has three taps by means of which the set may be tuned to the different wave bands. The use of plate voltages as they are employed here is unusual in this type of circuit, but as a "C" battery is employed on the audio frequency stages of amplification such practice is permissible. There are but two rheostats, one controlling the radio frequency stages and the other the detector and audio frequency stages.

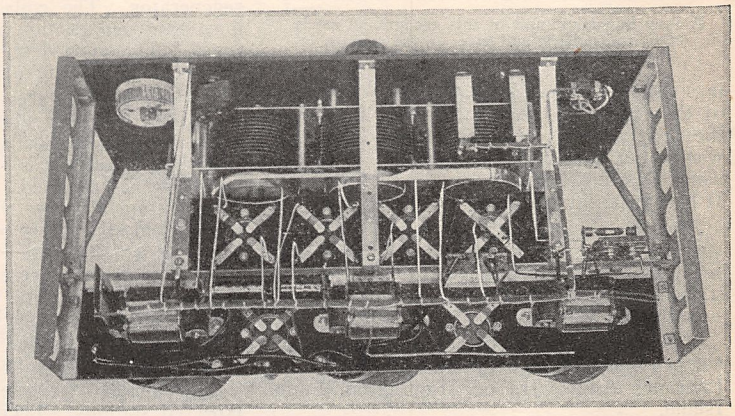
NO BATTERIES

Ever since radio receivers have received the power for their vacuum tubes from batteries, engineers have been endeavoring to obtain the necessary power from some constant source of current, as the house-lighting lines. As alternating current is almost universally used as a means of illumination throughout the country and as this type of current is easily stepped either up or down, it was decided to experiment with sets using A.C. Various types of filters were tried and various tricks with tubes, but still for the most part there was a decided note or hum audible, due to the 60-cycle current employed. Of course, on local stations the music received on the set drowned out this hum, but it was almost impossible to enjoy even fair reception from distant stations.

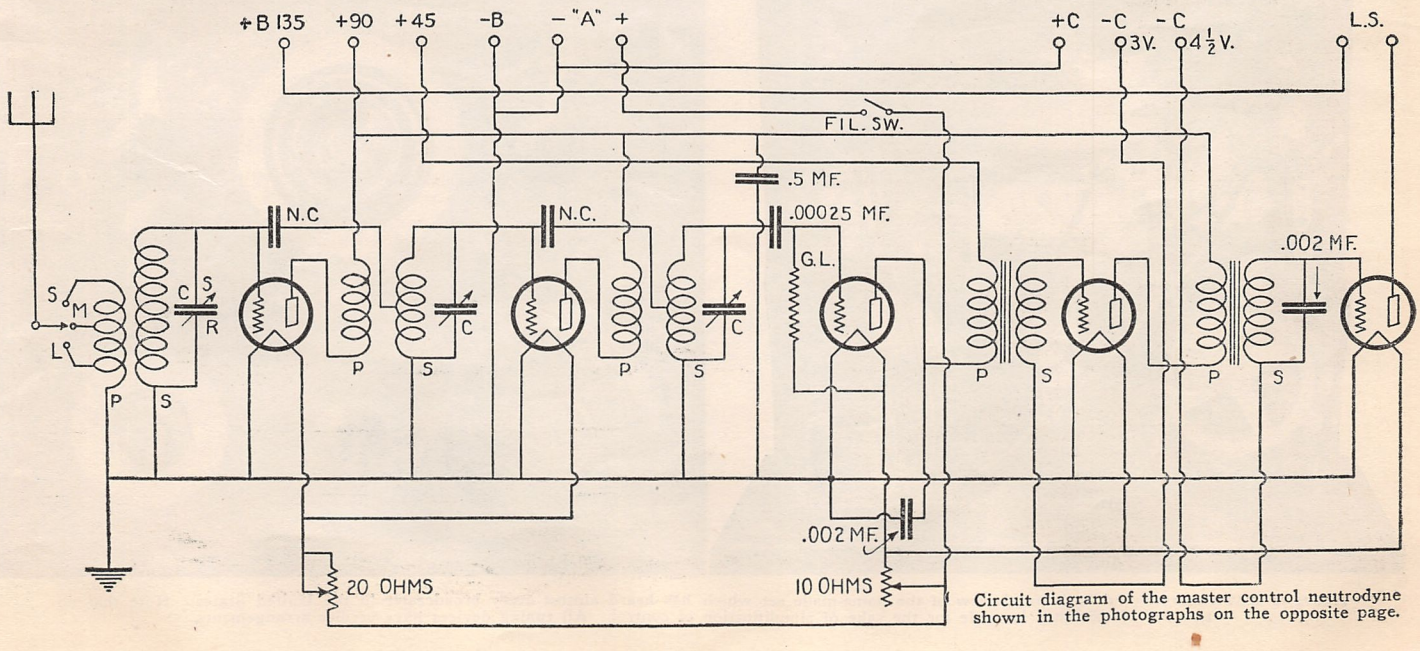
However, within the last three or four months announcements have been made of receivers that function in an efficient manner when operated from 110 volts A.C. One of these sets is here shown. The circuit employed for the receiver is tuned radio frequency with three tubes used as audio frequency amplifiers.

Connected to the 110-volt 60-cycle line is the transformer shown in the diagram. There is another winding to the transformer beside the usual two, and this is for lighting the filaments of the rectifier. There is a tap in the secondary of the transformer, which supplies the correct voltage for the filaments of the vacuum tubes used in the receiver. The filter for smoothing out the rectified A.C. consists of a coil and two fixed con-

(*Continued on page* 1078)



In this view may be seen the sturdy bridge construction and well-spaced wiring of the batteryless receiver.



Circuit diagram of the master control neutrodyne shown in the photographs on the opposite page.

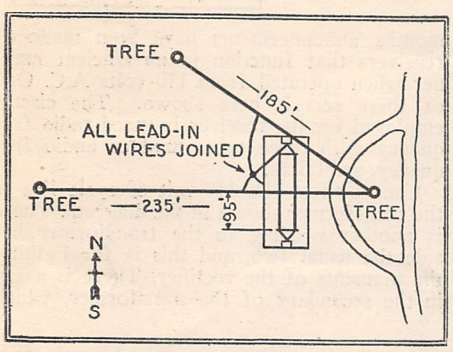
One-Tube Regenerator Brings in Coast

By HERNDON GREEN

Freak distance reception—or reports of it, rather—are common. But when transcontinental stations are heard regularly on one tube—that is really interesting. Read below how it is done.

WHENEVER a resident of Long Island slips up to me on the commuting train in the morning and says, after a proper pause, "I picked up KGO last night," I at once put him down as a competitor of Münchausen or else have pity for a chap who has become such a fan that he even lets his ears deceive his better judgment.

This very thing happened the other morning. But the difference was that the narrator of the experience began by telling how good the program was and naming names. This was so out of the ordinary that it made the usual classification quite out of the question. It had to be investigated.



A very important unit of this exceptional set is the multiplicity and size of the aerials.

And the curious part of this is that the statement was *true*. Not only that, but KGO is just one of the many West Coast stations which the young gentleman receives—and quite regularly.

The owner and operator of the wonderful set which brings in such great DX is Laurance Angel, Jr., of Huntington, Long Island.

Now for the surprise. The set is a one-tube double-circuit blooper, no less; and all home-made of a most curious assortment of parts.

After he made the original statement about picking up the Coast and being able to describe the program—there was nothing to do except ask to see the set. He was more interested in the program than in the feat of picking up the station, since that particular piece of DX is more or less ordinary to his set. As a matter of fact, he has been in almost regular touch with the Pacific Coast ever since he constructed the set and put it into operation some two years ago.

"It is nothing extraordinary, the set, I mean," said Angel. "Just an ordinary double-circuit tuner with some extra refinements which we have put on from time to time."

The Angel residence is situated, like most of the houses on Long Island, in the midst of a more or less flat town, a few hundred feet from the shore. The set is installed in a room on the second floor. The lead-in from the antenna—or rather antennae—comes in directly to the instrument.

An examination of the set showed, indeed, that it was nothing out of the ordinary. That is, not much out of the ordinary. The primary circuit was simply a double-circuit regenerator. The coils were tapped in the most approved fashion and every circuit was tuned. A detailed description of the set will be found at the end of this article.

Not the least interesting point in connection with the room where the set is located is the fact that the walls are literally covered with letters and cards from various stations which he has received. They are tacked up in profusion all over the room. There are notes from all corners of the country, north, south, east and west. Many of them are more than proof of reception notes. Among others, there are some which note the fact that Mr. Angel is official observer for the station in question and is at liberty to wire them telling of their modulation, etc.

And not all of the letters are from high-powered stations. There is one in particular from a station in Michigan which has an input in the neighborhood of ten watts. This letter, together with some other of the most interesting ones, are produced below:

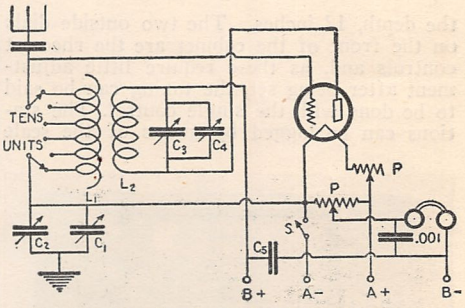
Menominee, Mich, January 2, 1923.

Mr. Laurance Angel, Jr.,
Huntington, L. I., N. Y.

Dear Sir:

Accept our congratulations on your excellent reception of our signals, inasmuch as the reception you report is the output of two five-watt tubes only.

May we ask you to listen in for our future programs and you may feel at liberty to send us a telegram at our ex-



Here is the circuit employed in Mr. Angel's one-tube set which brings in the Coast.

pense at any time you hear KFLB broadcasting.

Hoping to hear from you next Wednesday evening, by telegram, we are

Very truly yours,
E. W. KIRSTEN,
Operator.

That his ability as a DX fan is appreciated by the broadcast stations may be judged by the following letter from one of the important stations on the West Coast:

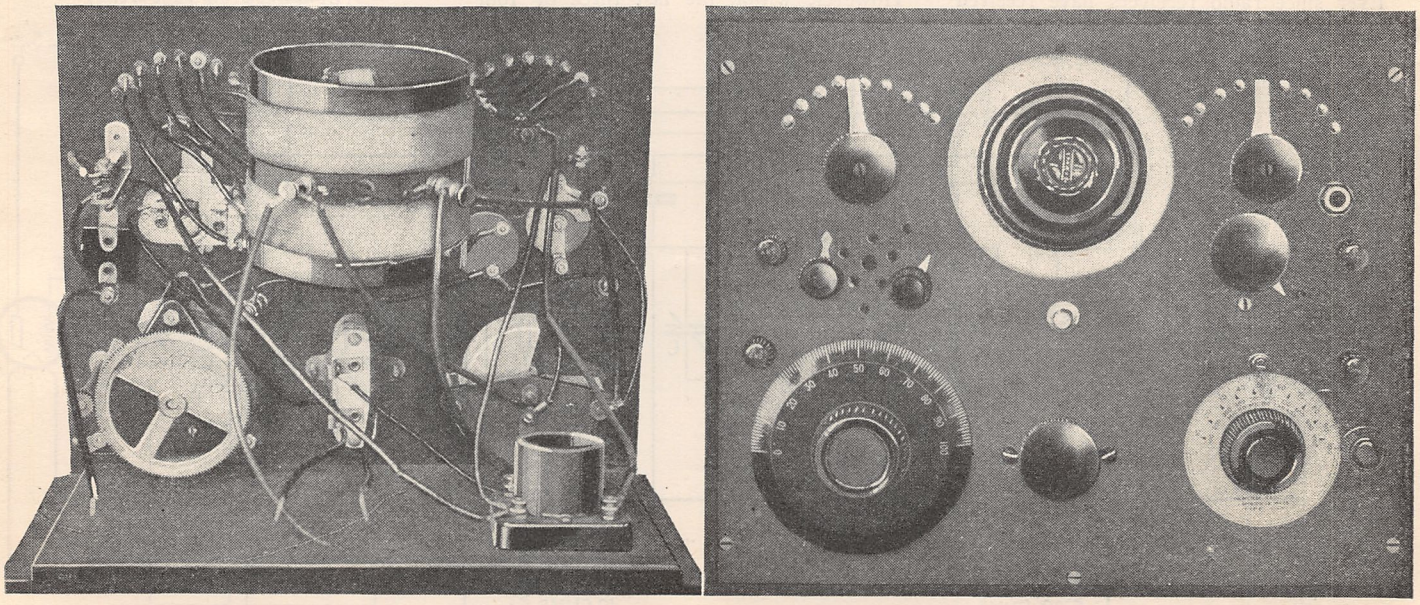
Radio Station KNX,
Los Angeles, Calif.

To Whom It May Concern:

Please be informed that the bearer, Mr. Laurance Angel, Jr., is our official test radio man for the Eastern Coast.

Any co-operation you may be able to give him along radio lines, especially for

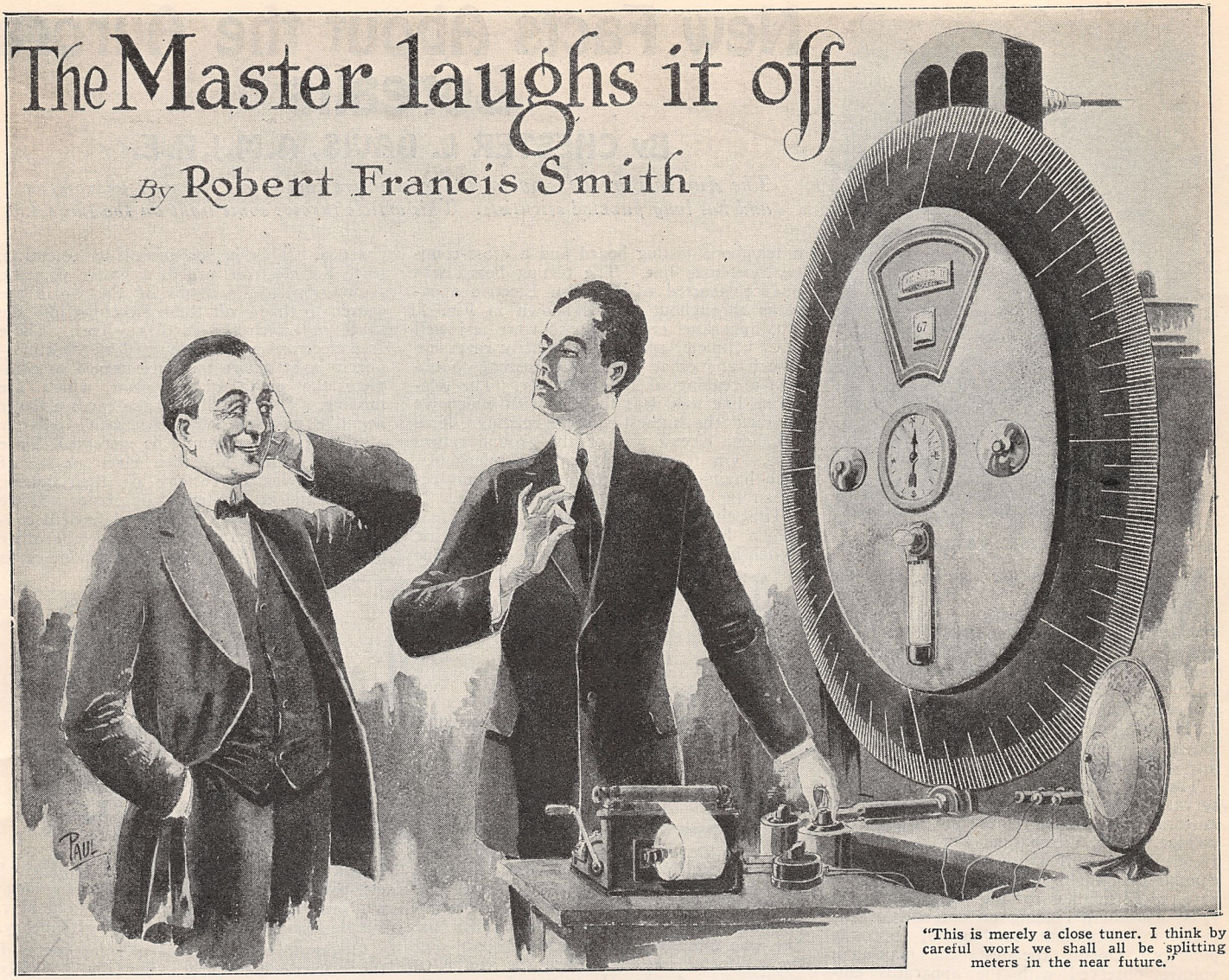
(Continued on page 1054)



Above is shown a front and back panel view of the home-made set which has heard almost every broadcaster in the United States. Note that no sacrifice of efficiency is made for the sake of simplification of control. All tuning devices have vernier arrangements.

The Master laughs it off

By Robert Francis Smith



"This is merely a close tuner. I think by careful work we shall all be splitting meters in the near future."

"HAW," says the comedian, "she wasn't fat. Her total volume was only six cubic feet less than a boxcar."

I'm standing in the wings, looking through a peep-hole at the audience. More in particular, at one member of the audience. This individual is wearing a nifty tux, a solemn expression, and is alone. He's young, good enough looking normally and very much so dressed to kill. In fact, there's a last year's chicken next to him that looks like she'd give her chance of salvation just to listen in onto a little love broadcasting by station JERRY. But he don't give her a tumble—she don't even get a trip.

It's during the first act of the *White Lights Revue,* in which we're featured. The present number is a comedy bit, followed by a chorus number in which the girls toss balloons out into the audience. Jerry's right in the front row, and I sees there's several girls trying to sock him with their inflated rubber balls. Finally, a little red-head, Irene O'Leary, succeeds in hitting him on the ear with a green balloon. Jerry don't pay no attention, actually scowling at the girl. Whereat Irene makes a face and turns off. I can see she's mad, but she don't say nothing until later, when Doris asks her to have supper with us and Jerry.

During the remainder of the performance Jerry looks like the worst man at a funeral. The best gags go so far over his head they skim the ceiling. Pretty soon we goes on for a bit. Joe Hammerstein and Doris Darling. Doris Darling is Wifie Dear at home in Brightmere-on-the-Deep. We dances, getting a good hand. Jerry's managed to get away from his laboratory long enough to drop in and see the new revue we're with. During our bits we has a few gags, at which Jerry laughs, not because he gets them, which he don't, but because he knows that my saying them makes them funny. If all audiences were like The Master—that's Jerry at home—I'd be laying bricks, or polishing Fifth Avenue.

After the show, The Master joins us, and Irene's along to keep Jerry from lapsing off into radio meditation. This young lady is both young and a lady—when necessity demands. Jerry ain't exactly used to women, further than hearing them over the ether, and the few locals in Brightmere that his wealth and position causes him to have to drag out occasionally. But Irene O'Leary ain't no amateur, even if she is—actually, not press-agentally—nineteen summers and a winter or so thrown in.

"Oh, Mister Lawson," she coos, on being introduced. "Joe and Doris have been telling me *so* much about your wonderful radio work!"

"Yes?" answers Jerry, reddening slightly. I sees he don't recognize Irene as the balloon girl, and I imagines he's wishing he were back where the UVs glow.

"I'm interested in it, too."

"Really?"

"Yes. What do you consider the arguments in favor of the heterodyne over the neutrodyne?"

Give her credit—she plays her hand like a three-card monte man. I think maybe Irene's got a crystal set somewheres at home, but she don't know a loop aerial from a stalled subway car. However, we shuts up and lets The Master explain. Which he does—and how!

That takes most of the time as we're walking up the street to the supper club where food is due. When we arrives at our table Jerry really gets warmed up to his subject, Irene flagging him with an occasional well-put question she musta got outa some radio magazine. Anyway, The Master ain't stuck her—he ain't tried, I guess—and by the time supper's over Jerry thinks Irene O'Leary is the cat's antennae. On our way out to Brightmere Jerry enthuses.

"Such an intelligent youngster," he declares. "Really, it's a pleasure to find someone amongst the ladies who can intelligently discuss radio."

It strikes me that it was more of a lecture than a discussion, but I stays silent. Let the good work proceed.

The next day's Saturday, which means work all day. It's late fall, and pleasantly cool. I'm making my morning stroll about the yard, poking at things in general, when Doris sticks her bob outa the window and yelps.

"Oh, Joe," she calls, "come here. I've gotta surprise for you."

"Do tell!" I remarks. "Somebody leave you a wad of jack?"

"No. We're to have a guest."

I grunts. "Surprise, huh? I thought maybe you'd got Africa on half a tube."

"Bring your so-called brains along, and I'll explain," commands Doris.

Inside, it's like this: Irene O'Leary is to stay with us for a few weeks while her folks takes an excursion to Chicago for no given reason. It's jake with me.

"OK, as far as I'm concerned," I states. "But why the surprise end?"

Doris only smiles. "For once, Joe, you're not in on it. But I do hope that when occasions arise you'll remember the Alamo."

(*Continued on page* 1008)

New Facts About the Aurora Borealis

By CHESTER L. DAVIS, A.M.I.R.E.

The Aurora Borealis is one of the most interesting of all Nature's phenomena and has long puzzled scientists. This article throws some light on the subject.

CHESTER L. DAVIS

MANY people are familiar with the phenomenon of the Northern Lights. Probably most people know less about the Aurora Borealis than they do about the sun, moon and stars. In fact, most people know nothing about it, other than the fact that they are aware of the sky's being of a peculiar hue It is very much regretted that the Aurora Borealis is not present in this country for any great length of time.

The experiments herein described and observations given seem to prove that the Aurora Borealis develops an alternating voltage. This alternating voltage is of a frequency lower than any that is used in the commercial world. It was found that it required 14 minutes for the voltage to travel from maximum reading on one-half of the cycle to maximum reading of opposite polarity. During the tests the maximum voltage observed with the apparatus employed was 28 volts. This value was not constant. The experiments, as they were conducted, will be described in the order that they were performed.

The sky was streaked with light. Sometimes the light would flash and often would change its position in the sky. Telegraphs, telephones and wireless stations were troubled with paralyzation of their instruments. The first experiment was conducted on my radio receiver. A voltmeter was connected to the antenna and ground, but no reading was obtained. The antenna in use was 80 feet in length. After this test, an ordinary 25-watt lamp bulb was connected to the antenna and ground connections. No effect was noticed. The third experiment

That the Aurora Borealis is responsible for an alternating current set up in the earth, has perhaps never before been brought out. Mr. Davis, in this article, describes exceedingly interesting experiments made some time ago which show that the Aurora Borealis is responsible for an alternating current of the astonishing cycle of a 15-minute frequency.—EDITOR.

was the same, excepting that a flashlight bulb replaced the larger one, but nothing happened. The next experiment was the one which disclosed some remarkable facts about the nature of the Aurora Borealis. A full description of all apparatus used in this experiment will first be given.

THE VOLTAGE TEST

The apparatus used in this experiment was a telephone testing board and a cross-country telephone line. The testing board was one constructed of Western Electric apparatus throughout and is shown in Fig. 1. The apparatus on this board were a Jewell D.C. voltmeter scale 0-30, polarity reversing switch and other switches necessary to obtain a reading of the voltmeter. The telephone line used was the one with which we obtained the highest voltage reading. This telephone circuit was of the ground return type. On it were 14 bridging telephones, each having a resistance of 1,600 ohms between the metallic and ground circuits.

The circuit used in making the test is shown in Fig. 2. The telephone testing switch-board was connected to one of the

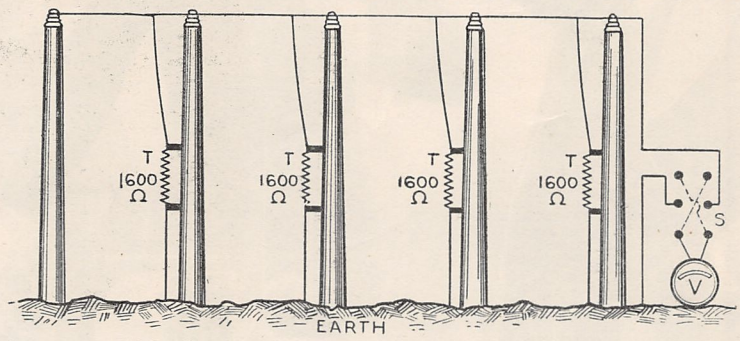


Fig. 2. The circuit that was used in the tests. It was found that the voltage indicated by the voltmeter, V, rose and fell to 28 volts following the behavior of alternating current. The reversing switch, S, was used only to get a reading on the meter.

lines on which the interference was most noticeable and annunciator drops on the switch-board were falling, as though someone were ringing the operator. When the line was connected to the testing board and the voltmeter switch thrown, the voltmeter needle rose slowly. I continued to watch it rise until it reached a reading of 28 volts. It remained at this value for no length of time, but began to slowly fall to zero. I waited patiently for a considerable time, all the while wishing that the voltage would return. After waiting for nearly 15 minutes the needle again began to rise. After the needle had returned to zero once more, and a period of 15 minutes had elapsed, the needle performed as before. It was the regular reading of the voltmeter and the regular occurrence of the waiting of 15 minutes that suggested to me the idea that probably the voltage was of an alternating polarity. Anyway, that would explain what was taking place during the 15 minutes of waiting. A polarity reversing switch was employed to reverse the polarity of the voltmeter and the voltage was found to duplicate the performance. Whenever the voltmeter needle fell to zero the polarity on the voltmeter was reversed and reading on each half of the cycle was obtained in this manner. The experiment suggested to me the simplest apparatus to illustrate an alternating voltage.

Only one characteristic was obtained in regard to the amperage. A simple electric door-bell was connected, as was a small lamp bulb, to the circuit, but no indications of voltage were noted by the bell and lamp test. Other than the fact that there was sufficient amperage to cause the drops on the telephone switch-board to fall, I discovered nothing about the amperage developed.

AN EXPLANATION

The theory I have advanced regarding the phenomenon is as follows:

Let us suppose the earth to be negatively charged. This is recognized by scientists, since the electrons are of negative polarity. Now suppose the atoms of the world are caused to throw off these electrons into the space in which the earth revolves. These free electrons will be attracted by the atmospheric layer where they are needed to complete the quota of electrons which are missing. This would give the earth a lower negative polarity and the negative polarity of the atmosphere would be increased. Since the atoms which lose their electrons are of positive polarity, because of their nuclei, there would be a potential difference. If we consider the earth to be one plate of a condenser and the atmospheric layer the other plate, we may say that the condenser is building up and discharging its voltage of one polarity and then charging and discharging the opposite polarity. This would be a simple oscillating circuit of low frequency.

Owing to the fact that in some parts of the country the Aurora Borealis is barely visible, uniform voltage would not be found. I noticed that when the sky began to darken

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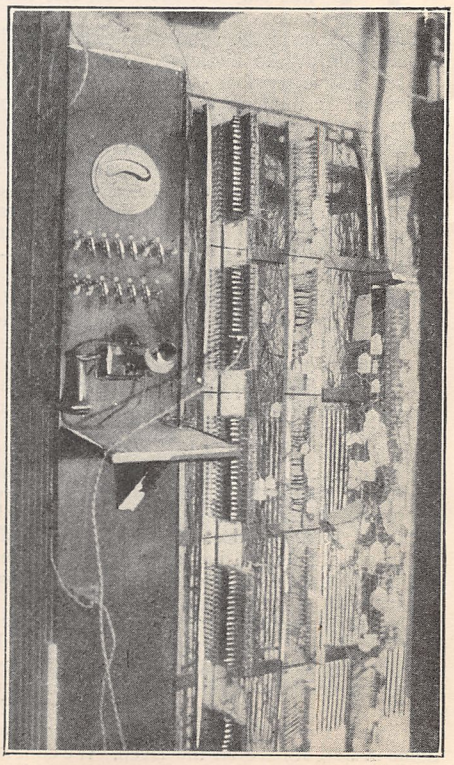


Fig. 1. The telephone test board employed in the tests described above, was of standard apparatus, using 14 bridging telephones.

Testing Building Materials by Radio

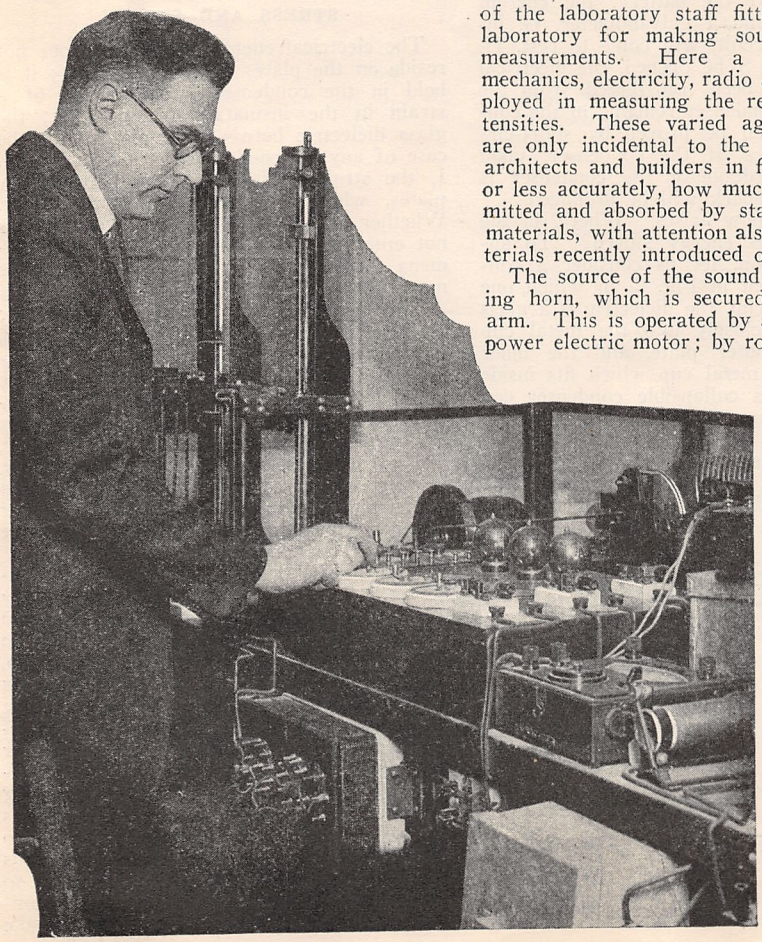
By S. R. WINTERS

Relatively little has been known heretofore about the acoustic properties of various building materials. In this article is told how the Bureau of Standards is attacking the problem.

AS STRANGE as it may seem, the type of loud speaking device that you use to deliver radio entertainment to the family circle may be instrumental in circumscribing that music within the walls of your own home, lest it prove annoying to a next-door neighbor. This apparent ring-within-a-ring analogy may be explained by stating that the Sound Measurements Section of the Bureau of Standards is using a conventional radio loud speaking horn in experiments designed to determine the relative sound transmitting and absorbing properties of different kinds of building materials.

OBJECT OF THE TESTS

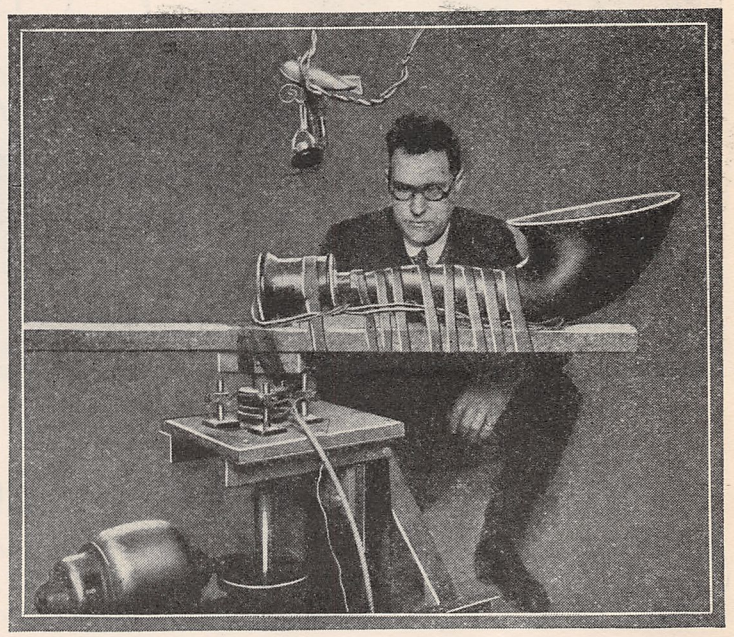
The object of these tests has been to determine the relative degree of sound insulation provided by the standard partition wall as it is used in ordinary building construction. The results thus afforded will later serve as yardsticks to determine the relative merit of constructions and materials designed and used to secure exceptional sound insulation. Thereby, it is hoped, that apartment houses and residences that are constructed in the future will not only confine radio entertainment within the home or apartment in which it is given, but that the conversation of the family circle and other noises in the respective households will not be imparted to neighbors. Unfortunately, many of the present-day homes and apartment houses both transmit and absorb sounds, and thus deny the privacy which they were intended to insure. You have doubtless heard the expression, "This house is like a sounding board," which frequently contains more truth than exaggeration.



The three tubes of the three-stage audio frequency amplifier may be seen in the photograph at the left. After passing through the amplifier the signals are rectified by a crystal detector and comparative readings are taken on the galvanometer.

Manufacturers of building materials, architects, builders and owners of homes and apartment houses have swamped the Bureau of Standards in recent years with requests for information relating to the acoustic qualities of building materials. In response to the pressing need for data of this character and mindful of the requirements of facilities for conducting such tests, Dr. E. A. Eckhardt, Chief of the Sound Measurements Section, V. L. Chrisler and other members of the laboratory staff fitted up a modest laboratory for making sound transmission measurements. Here a combination of mechanics, electricity, radio and sound is employed in measuring the relative sound intensities. These varied agencies, however, are only incidental to the object of aiding architects and builders in finding out, more or less accurately, how much sound is transmitted and absorbed by standard structural materials, with attention also to building materials recently introduced on the market.

The source of the sound is a loud speaking horn, which is secured on a revolving arm. This is operated by a one-half horsepower electric motor; by rotating the source of the sound the vibration waves are not concentrated in one direction, but are scattered in all directions, thus making for uniformity of distribution of the sound. The radio loud speaker is located in the basement of the sound chamber, and two measuring rooms are located, respectively, above and beside the source of the sound. Partition walls, 6 x 7 feet and six inches in thickness, are secured in position above the loud speaker. A conventional head telephone receiver, such as commonly used in radio reception, is employed for measuring the intensity of the sound, both above and below the test specimen when in position. That telephone receiver is suspended by means of a wire, and may be thus elevated or lowered above or below the test specimen.



The source of the sound is a loud speaker secured to a revolving table. This is done in order to throw the sound waves in every direction against the specimen under test. The suspended head-phones are for picking up the signals after they have struck the specimen.

HOW THE SOUND IS MEASURED

The actual sound-intensity measurements are made and recorded on the main floor of this relatively sound-proof structure. The telephone receiver converts the sound vibration into a small alternating voltage which is amplified by a three-stage audio frequency amplifier. The output of this amplifier is rectified by means of a crystal detector and the rectified current measured by means of a sensitive galvanometer. The whole system is so designed that, with certain limitations which are known and considered, the galvanometer deflection is proportional to the sound intensity to which the telephone receiver is exposed.

By means of a potentiometer system an alternating current voltage is applied to the input of the amplifier and adjusted to such magnitude that the galvanometer gives the same deflection as with the sound measurement which had just preceded. In this way the sound intensity is expressed in terms of a definite voltage, the calibration of the amplifier cancels out and is, therefore, immaterial and all measurements are placed on a basis which makes them comparable.

This complicated-looking apparatus, which in part acts in response to laws of mechanics, electricity, radio and sound, has an intensity range of 1 to 10,000,000. The human equation in taking these measurements is more or less eliminated by the galvanometer.

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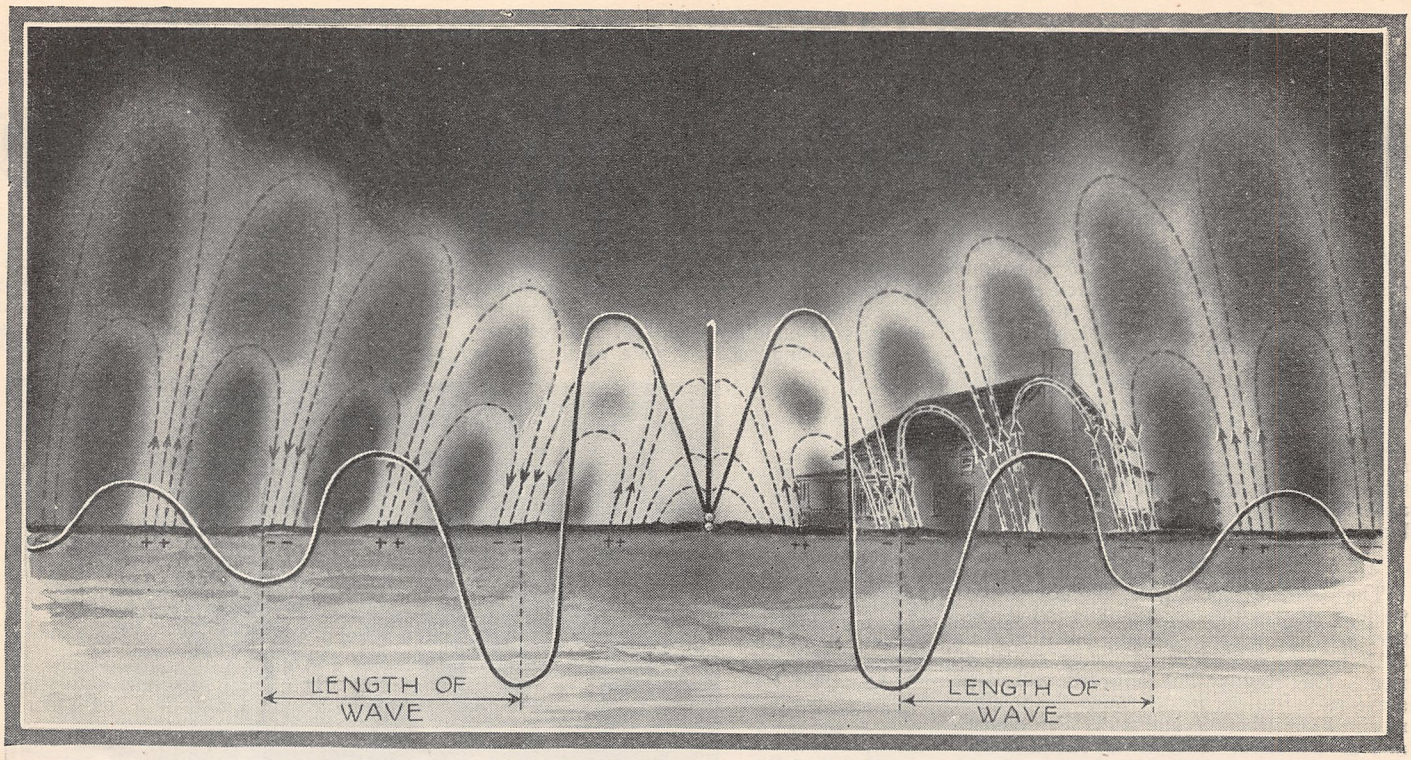


Here is how the artist visualizes the radio waves in space. The scale is very large, of course; if everything were drawn to the proper scale we could not see the house.

What Are Radio Waves?

An elemental explanation of the nature of a radio wave as it leaves the antenna and starts its trip through space has long been needed in the popular press. The following article will be easily understood.

By JOSEPH RILEY

A GREAT deal of interest has been shown of late in the theory of propagation of electromagnetic radiations and the mechanism by means of which the radiation of energy has been accomplished. Much has been written in the popular journals on this subject and it is needless to mention that such articles as have been published have fallen far short of describing the matter in full, or even in making a pretense at completeness. There have always been important phases of the subject omitted, either on account of ignorance of these, or on account of the difficulty of explaining the phenomena in a fashion understandable to the non-technical reader. The purpose of this article is to present to our readers a bird's-eye view of the subject and to attempt to clarify the matter by means of graphic illustrations and new analogies.

The knowledge of the phenomena going on in a condenser under the action of an alternating electromotive force is a prerequisite for this study. These phenomena will be sketched in a few words for the benefit of the new radio enthusiasts. When a battery or other source of electromotive force is connected to a condenser, one plate of the condenser is charged positively and the other plate is charged negatively. See Fig. 1. If the battery is now removed, or the switch, S, is opened, these charges will remain on the plates of the condenser.

In the beginning, before the switch was closed, no electrical energy was present in the condenser, nor had any energy been withdrawn from the battery. On closing the switch, however, current flows from the battery into the condenser, and continues to do so until the voltage between the plates of the condenser is equal to the electromotive force of the battery. This flow of current is momentary, lasting perhaps only for a few thousandths of a second, and is called the charging current.

When the voltage of the condenser is equal to that of the battery, the current ceases flowing and a galvanometer, G, included in the circuit, will come to rest. If, now, the switch S be opened, the electrical energy that has been transferred from the battery to the condenser remains in the condenser. This can be proven by short-circuiting the plates of the condenser, upon which, if the voltage or the condenser is high enough, a spark will be produced.

The question now arises, "Where, in the condenser, is this energy stored?" To answer this question, let us consider a condenser as pictured in Fig. 2, in which one plate is a metal cup, the dielectric is a glass cup which fits closely into the metal cup acting as the outer plate, and the inner plate is another metal cup which fits inside the others. This collapsible condenser can be charged, in any convenient manner, as by an influence or static machine, disassembled by lifting out one cup after the other with a rod of insulating material, and then can be handled safely, without any fear of sustaining an electric shock. On reassembling the condenser, however, a strong spark can be obtained from it by short-circuiting the two plates.

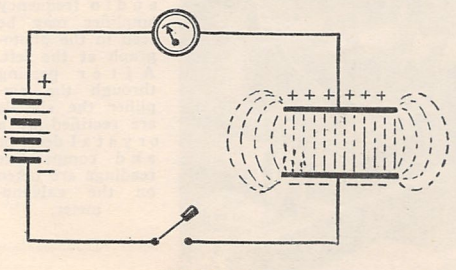


FIG. 1

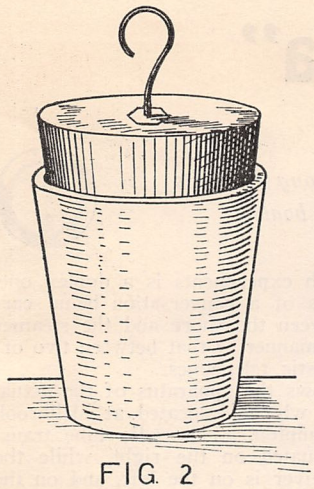
The fundamentals of wave propagation can be learned from a study of the simple charge and discharge of a condenser.

STRESS AND STRAIN

The electrical energy, therefore, does not reside on the plates of the condenser; it is held in the condenser in the shape of a strain in the insulating medium, *i.e.*, the glass dielectric between the plates. In the case of any air condenser, as shown in Fig. 1, the strain is in the space between the plates, which has been called the ether. Whether or not the ether really exists does not enter into this discussion. The phenomena remain the same, whatever means we may use to interpret them.

This strain in the medium between the plates is somewhat akin to a deformation. For an analogy, think of a bar of iron resting on two supports at the ends. If we press down at the middle of the bar, a deformation, or change of shape results. This is the *strain*. The opposing force in the bar, due to its elasticity, is called the *stress*. Energy is required to bend the bar, to set up the strain, but once it is bent, no further energy need be expended, although the force must still be maintained.

The same is true in the case of the condenser. Energy is taken from the battery to set up a strain in the medium between the plates. Once the strain is set up no further energy is required to keep it set up, for we have seen that the current ceases flowing and the switch may be opened. The force, or voltage, however, must be maintained between the plates of the condenser to keep the medium in the strained condition. If it is removed by short-circuiting the plates, the strain disappears. Just as the stress in the bar would cause it to spring back when the force is removed, thus allowing the deformation to disappear, so the stress in the medium between the condenser plates will cause the spark to take



By means of this collapsible condenser, we learn that the energy of the charge is held in the space between the plates, or in the glass.

FIG. 2

place if the voltage is removed, thus allowing the deformation to disappear, so the stress in the medium between the condenser plates will cause the spark to take place if the voltage is removed by short-circuiting, thus allowing the deformation (strain) in the medium to disappear.

We have seen before that energy is required to bring the stresses and strains into existence. It follows from this that energy is likewise required to produce any *changes* in the stresses and strains, and furthermore, there is no reason why we cannot think of this energy which is being imparted to the medium between the condenser plates in the same way as we think of an electric current transferring energy from one part of an electric circuit to another. As a matter of fact, this is exactly what we do; the strained condition of the medium is called the *displacement*, and variations of changes in this displacement (due to transference of energy from the battery to the condenser) are known as *displacement currents*.

DISPLACEMENT

Displacement is a measure of the electrostatic field intensity in the medium; the greater the displacement and the field intensity, the greater is the force between the plates. The greater the variation of the field intensity or displacement, the greater is the energy transferred and the greater is the displacement current.

Now, before going any further, let us consider another analogy. Suppose we place a stick in a pool of still water and slowly move it in one direction. As we move it we will notice that the water in front of the stick is gradually traveling around the stick to the back. The energy given up in moving the stick is utilized in setting up vortex currents in the water around the stick and very little is utilized in pushing the water ahead of it. However, if the stick is moved very suddenly a short distance, it will be noticed that the water at first piles up in front of the stick and then flows off ahead of it in the form of a wave. Both the vortex waves going around the stick and the advancing wave in front of the stick are formed, no matter what the speed with which the stick is pushed, but when the speed of the stick is small the advancing wave is not very prominent, nearly all the energy in the stick being utilized in forming the vortex waves. On the other hand, when the stick is moved very quickly a short distance, the vortex waves are not so noticeable while the advancing wave is relatively great.

If, after being pushed quickly a short distance, the motion of the stick is reversed, waves in the opposite direction will be formed, while the first wave continues to travel outward.

Although we have not said very much so far about radio waves, we are beginning to see a little light on the subject. There are many things in this life which are difficult to visualize directly, especially in connection with the conceptions we meet in the study of radio, and it becomes almost necessary to *feel* these things; as a matter of fact, there are many of these conceptions that we can *feel*, after having come into contact with them many times, but yet cannot explain clearly or fully. The highly technical scientist, although he can discuss these things clearly and volubly from the mathematical view-point, which is in most cases the best view-point, often has great difficulty in forming good physical conceptions of the phenomena with which he happens to be dealing. So it is with the conception of the electromagnetic waves of radio. We cannot see them, feel them or even measure them directly. We must measure them by indirect methods, and we must visualize them by means of the things they accomplish. We are helped considerably by analogies, as we have seen above, but we must be careful not to carry the analogies too far. However, it is mostly by means of analogies that we are enabled to form a clear and consistent idea of the radio waves.

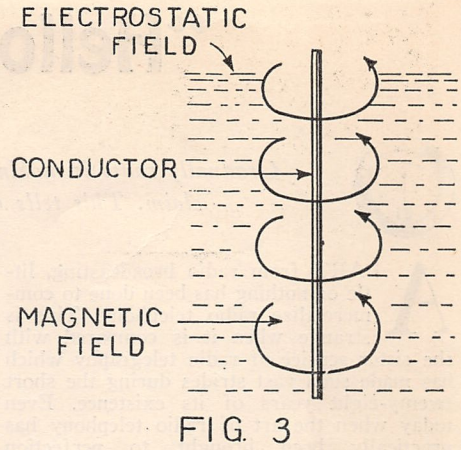


FIG. 3

The lines of electric force emanate radially from a uniformly charged vertical wire.

The conception of lines of force in a con-

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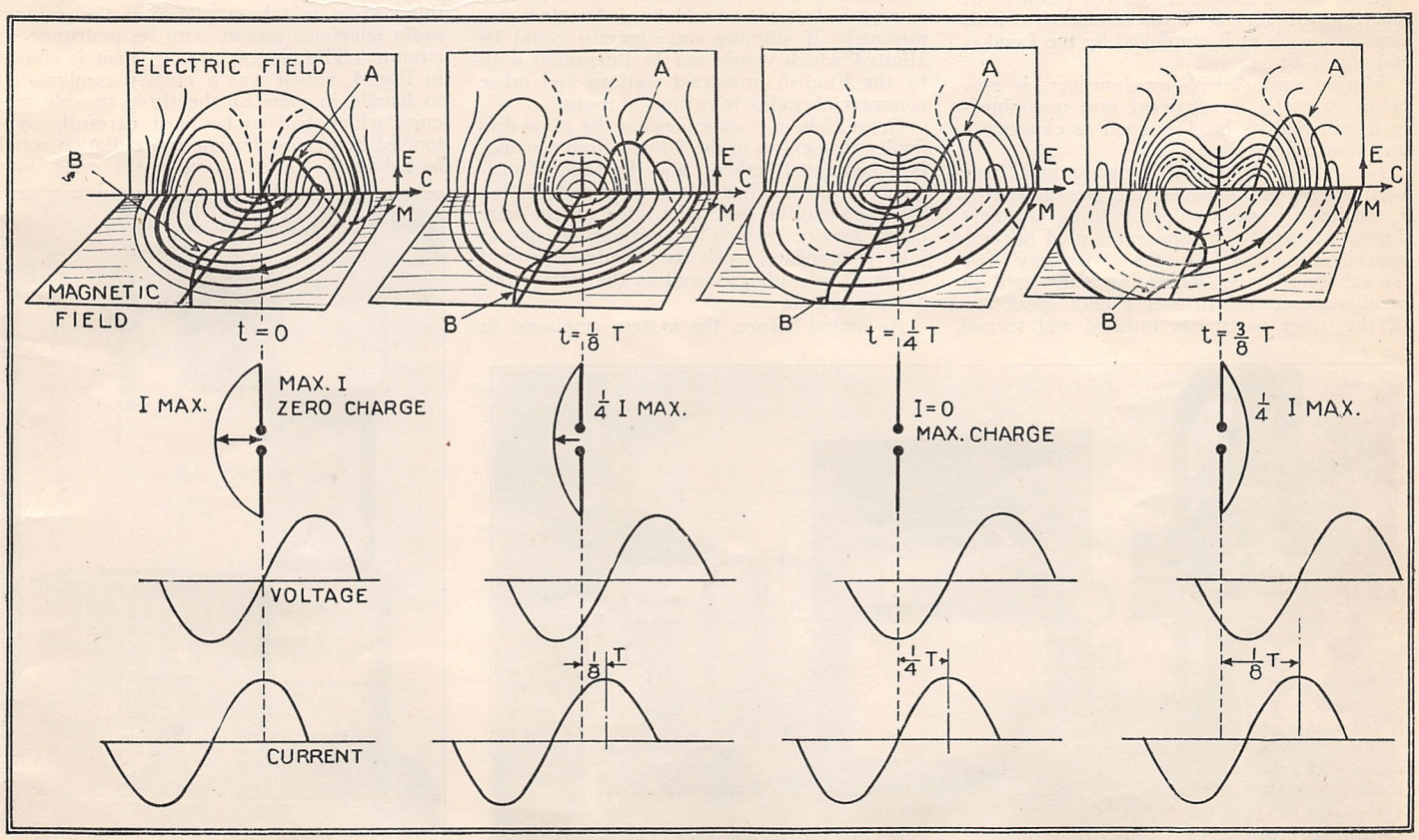


The form of the electrostatic and magnetic fields at several instants in the cycle are shown here; also the distribution of the charge on the antenna, and the voltage and current distribution.

"Hello, Give Me S. S. Lucia"

By H. De A. DONISTHORPE

Gradually radio is making telephone service absolutely "universal"—which has long been its claim. This tells of telephone service established in England with Channel boats.

APART from radio broadcasting, little or nothing has been done to commercialize radio telephony. This is strange when it is compared with the sister service of radio telegraphy which has made such vast strides during the short twenty-eight years of its existence. Even today when the art of radio telephony has practically been brought to perfection

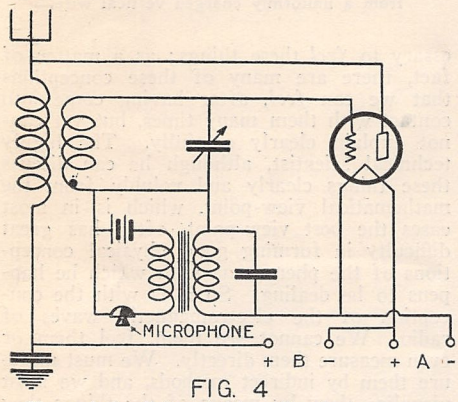


FIG. 4

The real simplicity of this radio telephone service is shown by the above hook-up.

through the aid of broadcasting there exists little or no commercial radio telephony, although we are promised a transatlantic service in the near future.

Radio telephony at present is practically confined to the exchange of conversations between mobile stations, or between mobile stations and a fixed station. An example of this type of service is the connection with airplanes, such as is employed by the London and Paris air service.

Marine radio telephony, however, is now being earnestly constructed and undoubtedly it will find its level as soon as experience has shown its value.

For some little time conversations have been exchanged between the passengers of a certain European shipping line's steamers during passage. The apparatus used in these experiments was of the "one-way" or "switch-over" type, which is rather hard to manipulate, as the listener cannot speak until the other party has finished and turned off his transmitter and switched on his receiver. These communications, therefore, can only be classed as interesting and enterprising experiments, as naturally they could not be applied for continuous practical service.

FIRST EXPERIMENTS

In 1919 some earnest work was carried on with duplex radio telephony and some astounding results were obtained. These experiments were carried out by the American Telegraph and Telephone Company in conjunction with the Western Electric Company. For this work a station was erected at Deal Beach, New Jersey, and communications were established with certain ships at sea especially equipped for these tests. Unfortunately these experiments have not been continued, and the results obtained have not yet been commercialized for general use, although the actual station at Deal Beach is still in existence, but it is hoped that one day in the not too distant future it will be reopened for public service.

At the present moment further experiments of a similar nature are being carried out on the other side of the Atlantic and an experimental duplex radio telephone service has been established between certain steamers crossing the English Channel and a land station located at Southampton in Hampshire. These experiments have been carried on in conjunction with the British Government, whose Post Office department has lent land-lines for the working out of the complete scheme. This service at present is reserved for the use of the shipowner issuing instructions to his steamers, but a perfect commercial service could be undertaken immediately if suitable wave-lengths could be allotted which would not be interfered with by the English broadcast stations and other commercial radio telegraph stations.

Great Britain is experiencing the same difficulty that exists in the United States, namely a congested "ether," and the time is anxiously awaited when a careful redistribution of wave-lengths will take care of the new radio services which have recently sprung into prominence, such as broadcasting and aeronautical radio, as well as the service under discussion.

As stated before, the system employed in these English experiments is a duplex one, which allows of a conversation being carried on between the shore and the steamer in the same manner as that between two ordinary domestic telephones.

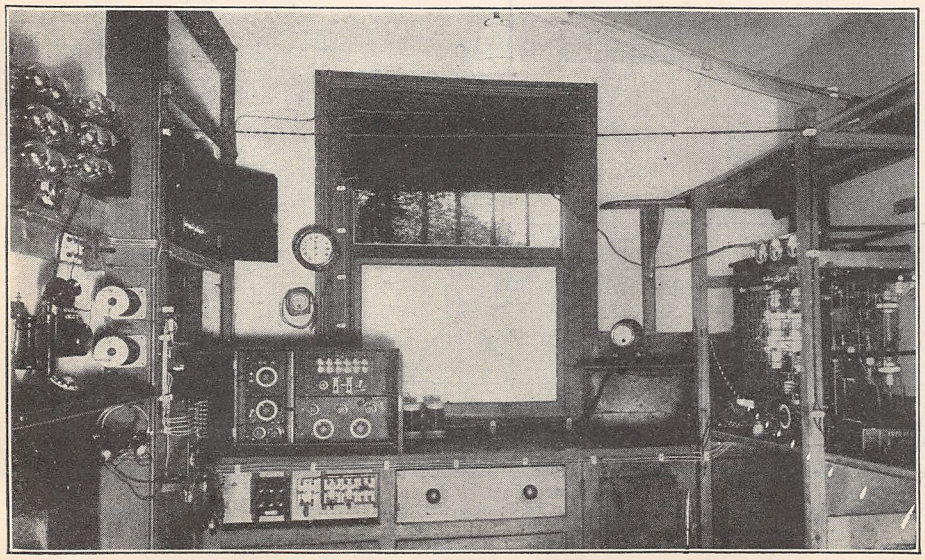
Fig. 1 shows the apparatus of the actual land station which is located at Millbrook near Southampton. The radio tube transmitter is situated on the right, while the shielded receiver is on the left, and on the extreme left is shown the telephone apparatus proper with switches for connecting the radio signals to the land lines which carry the energy to the public telephone exchange.

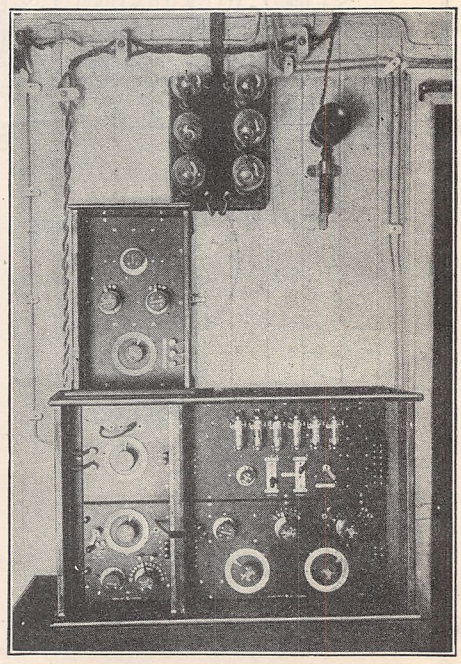
Figs. 2 and 3 show respectively the transmitter and receiver of the ship's installation. The transmitter is rated at 400 watts and is capable of maintaining reliable communication with shore when at a distance of 100 miles from the shore. In this connection it must not be overlooked that this service is restricted to the English Channel where great distances are not required. Satisfactory communication of a commercial nature has been carried on between the shipping company's office in London over the somewhat long land line from London to Southampton.

A problem still awaiting solution is the elimination of interference from neighboring "spark" radio telegraph stations. It is an established fact that it is easier to eliminate the jamming from an "undamped" wave station installed on the same table as the receiver, than to eliminate the "spark" interference from other ships many miles away.

EARLY DIFFICULTIES

Now for a few words on the technical side of the subject. It will be of interest in this respect to take a glance at the original radio telephone circuit with its multitude of circuits. The pioneer arrangement is shown in Fig. 4, which was a clumsy combination to handle in view of the three tunable circuits which had to be most carefully syntonised before oscillation and radiation could be achieved. Then again in the early days





The view to the left gives the interior of a typical coast station where land lines terminate and the radio link begins. Above is a ship station.

arcs, which are troublesome to handle when a steady current is desired, were utilized for the production of the undamped carrier wave. Compare this historic arrangement with the modern circuit with its few adjustments, shown in the same figure.

Another difficulty experienced in the early days was the microphone, which was inserted directly in the antenna circuit. This caused the carbon granules of the old type microphone to become heated rapidly with the result that they became stuck together and would no longer operate, so that the antenna current was no longer modulated and the set ceased to function as a telephone.

The progress made with thermionic tubes and their circuits is largely responsible for the success of modern telephony. As most of the readers of this article are familiar with the working of the tube and tube radio circuits it will not be necessary to discuss them, so that the remainder of this article will be devoted to a brief description of the general arrangement of duplex circuits.

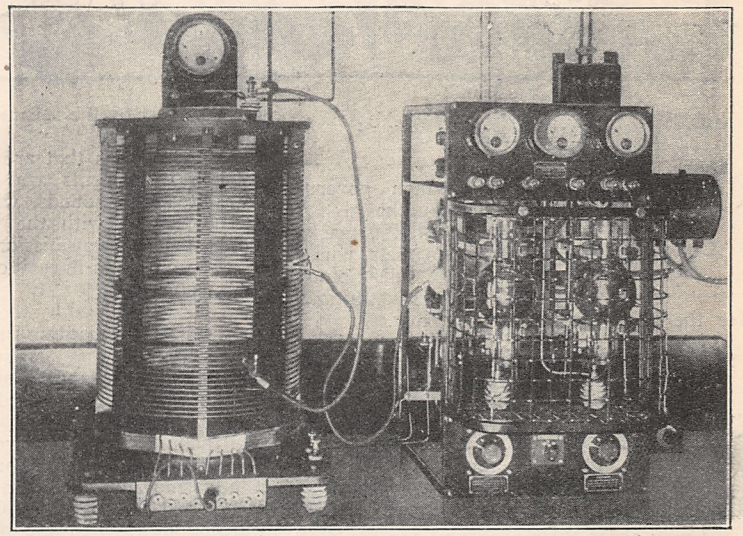
In order to establish the duplex effect, or a two-way system of radio telephony, it is necessary to employ two sets of wave-lengths for one particular combination of stations. It must not be thought that this is an extravagant use of wave-lengths as their separation need only be of a very small order, as will be seen later. The arrangement is for the transmitter of the land station and the receiver of the ship station to be on one wave-length, while the receiver of the shore and the vessel's transmitter utilize the other so that actually there are two channels of waves being employed. For example, in some of the experiments referred to, a 410-meter wave was adopted in the former case, and a 360-meter wave for the latter. How the two were interlaced will be explained further on in this article.

The necessity for employing these two waves is fairly obvious, the object being to prevent the signals of the actual transmitter from being received by the local receiver.

THE DEAL BEACH STATION

In the Deal Beach experiments the transmitting and receiving apparatus were located in buildings separated by about one mile, the receiving antenna in this instance being the well known loop such as is employed in most of the modern broadcast receivers, whilst in the Southampton tests it was shown that the transmitter and receiver are located in the same room.

Fig. 5 shows the general arrangement of the two sets of circuits at the one station and divulges the secret of how the two sets of waves are interlaced by means of the small coil shown at "X" which coil is sometimes named the hybrid coil.



The complete ship's unit is shown in this photograph. Many of the parts of the telephone are standard radio equipment.

An ordinary wave trap, such as is well known to the radio amateur, will achieve the same end and it is an easy matter to tune that trap at the receiving end so that the signals from that point's transmitter do not affect the signals due to the incoming waves from the distant station. In this manner it will be seen that it is possible to speak and receive at the same time after the fashion of the ordinary domestic telephone. Of course it is necessary for the signals transmitted to the land lines for passing through the public exchange to be of a high quality so that such a telephone service is somewhat limited by atmospheric conditions, as the presence of static causes the speech to be considerably confused after a magnification of the signals have taken place.

For marine work radio telephony would be of extreme value to the shipowner as instructions could be issued to the masters on his vessels direct from his office without any delay, and changes are frequently made at a moment's notice in order to conform with some alteration in the sailing of a vessel, so that the value of such a service can be immediately appreciated.

In conclusion, a few words about the possibilities of the projected transatlantic service perhaps may be of interest in spite of the fact that this particular aspect of radio telephony is not covered by the title of this article. On January 14th, 1923, an epoch-making experiment was carried out when Mr. Thayer, the president of the then American Telephone and Telegraph Company, talked from his office in New York to a number of distinguished scientists, engineers, and officials congregated in a London office by

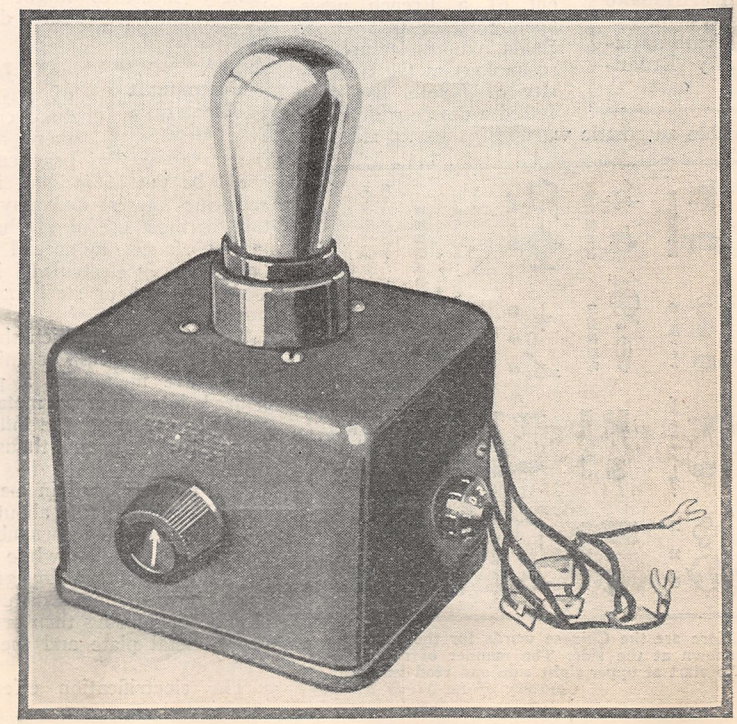
(*Continued on page* 1058)

The Radio Pup

THE diminutive receiving set shown in the accompanying illustration betrays a startling similarity in relative size, structure, and money value, to a great American automobile. It seems destined to become the "Lizzie" of radio, and will shortly inherit its own Joke Book, in which we shall find coy references to the effect that Mr. Cohen, while walking down town to his office, suddenly hears strains of Beethoven's Fifth emanating from the vicinity of his muscular diaphragm. A hurried X-ray treatment discloses the fact that he has mistaken his radio for a cough drop and swallowed it whole, batteries and all.

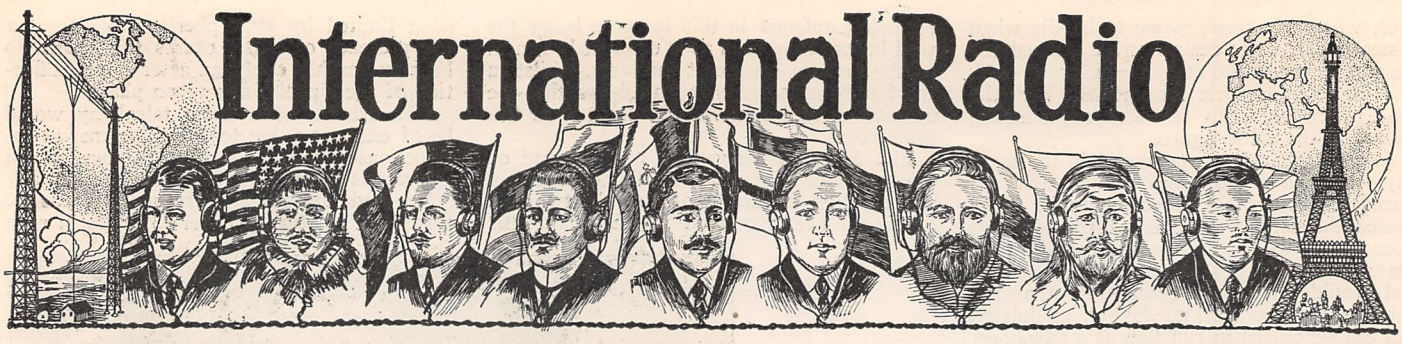
But, like its four-wheel *alter ego,* this outfit should thrive and multiply upon such jocular references. Mechanically, it is a good job. Electrically, it is an excellent, low-priced outfit and works very well. It is an excellent example of intelligent reproduction. A stamped alumnium case houses and shields an Armstrong regenerative circuit. It includes the book type condenser, a lattice grid coil which also serves as an antenna coil, and a lattice tickler which operates on the sliding rod principle common to larger sets by the same manufacturer. The rheostat and socket are standard models and the grid and by-pass condensers are of mica and copper-foil construction.

(*Continued on page* 1058)



Now radio has its $2000 Chinese console radio sets for the very rich and, like all well regulated industries, it has also its Ford type of set. This little regenerator, shown at the left, comes near being the Ford type. *Photo courtesy Crosley Radio Corp.*

International Radio



GERMANY

Government's Charitable Action

The German government has purchased for the sum of 43,500 marks 2000 receiving sets, which are to be distributed among all the institutions for the blind throughout Germany.

Dance Music to Order

The first broadcast station to offer dance music to suit any special listener is the one at Koenigswusterhausen, Germany. A system has been instituted whereby listeners who are giving dances or parties and desire to have radio music for these occasions may order their programs for the date and hour required.

The fee asked for this very useful service is said to be quite within the means of the average man and, according to a Paris newspaper, has proved to be quite an attractive feature.

FRANCE

Patron Saint of Radio

Some amateurs at the Naval Radio-Telegraphic School at Toulon were responsible for promoting the idea which has resulted in French radio enthusiasts adopting St. Joan of Arc as their patron saint.

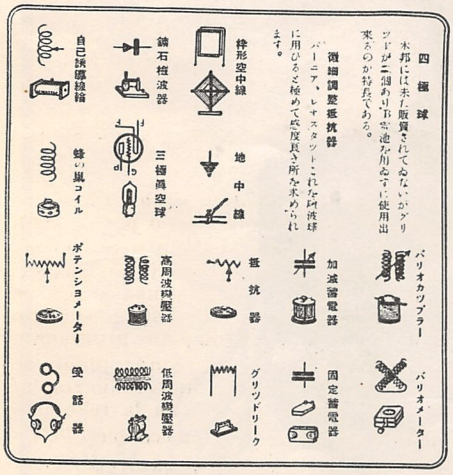
JAPAN

Earthquake Warnings Automatically Broadcast

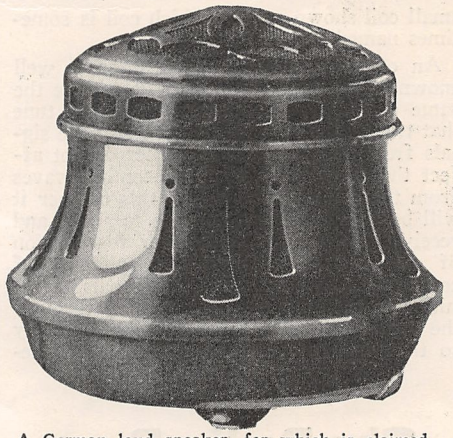
The Tokio correspondent of a French news agency states that Prof. Shida, who is lecturer in seismology at the University of Kyoto, has perfected a device which will enable automatic warning of earthquakes to be broadcast by the seismic recording instruments.

The vibrations that are recorded by these delicate instruments are by this apparatus translated into sounds, which are amplified and connected with the Government radio stations. The transmissions of the sound vibrations will then in each case be followed by an announcement of the general direction of the shock as judged by the seismic experts in charge of the recording instruments.

In countries that are subject to frequent earth tremors, such as Japan, violent earthquakes are usually preceded by very slight shocks, so slight that the inhabitants do not feel them. But they are recorded at the registration stations and, if broadcast, can serve as a warning of the shocks to come. In many cases, had it been possible to convey this warning quickly to the population, precautionary measures might have been taken that would have greatly diminished the loss of life.



Here are the Chinese words for the apparatus shown at the side. The manner of reading is to start at upper right side and read vertically. *Courtesy of La Studa Radio.*



A German loud speaker, for which is claimed remarkable reproduction, is shown above. It is built on reflected tone principle.

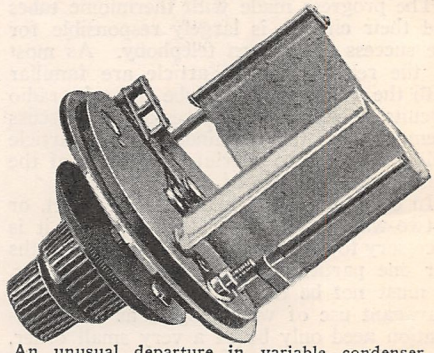
Permanent Electrification

A Japanese professor of physics has made a discovery which, although there appears to be no practical use to which it could be put at present, is of considerable scientific interest and may in the course of time be most useful. He has found that certain substances, by special treatment, may be "permanently electrified," in much the same way that iron or steel may be permanently magnetized.

The substances which show the effect best seem to be waxes, or mixtures of waxes. These are melted in a pot and are then poured into shallow metal dishes and allowed to set under the influence of a strong electric field of some thousands of volts per square inch.

The mixture used in many of the experiments consisted of about equal parts of ordinary resin and carnauba wax. The electric field is applied while the wax is cooling and hardening, by gradually lowering from above the metal dish, a metal plate, the electric field being then created between the upper metal plate and the metal containing dish.

The electrification effect is presumably due to some internal strains existing in the hardened wax. It is found that if the surface electrification is destroyed—for example by passing a flame over the surface—it will soon reappear, and this sort of treatment can continue for many months or perhaps years. One surface of the plate is permanently positive and the other is permanently negative.



An unusual departure in variable condenser construction has been put on exhibit lately, and is meeting with great favor in the French market. It consists of a regular dial and vernier system; but the condenser, instead of having the ordinary fixed and vernier plates, has two supple electrodes of bronze cloth which wind over a drum made for that purpose. There is a thin mica sheet placed in the position of a dielectric, but it is not meant to serve as a dielectric, but only as an insulator against possible short circuits. The actual dielectric is a thin air space between the two electrodes, the capacity of such a condenser without the air-space being estimated at ten times greater than the ordinary type.

Of course it is unlikely that an arrangement like this could be used as a battery, but there are many instruments where a high voltage is needed and where the current drawn from the source of the high potential is very small. In such case it seems quite probable that the permanently electrified plate can find a use.

GREAT BRITAIN

Speeding Up Programs

As a means of speeding up programs and smoothing out unnecessary intervals the British Broadcasting Company has installed in their London studio a new "box of tricks." This takes the form of a cabinet, in which the program director sits, controlling the microphones in three studios. He can switch smoothly from one to the other, or by means of a fourth switch he can interpose his own voice. In this way he can announce one number, while one studio is being emptied and another artist is preparing his act in another.

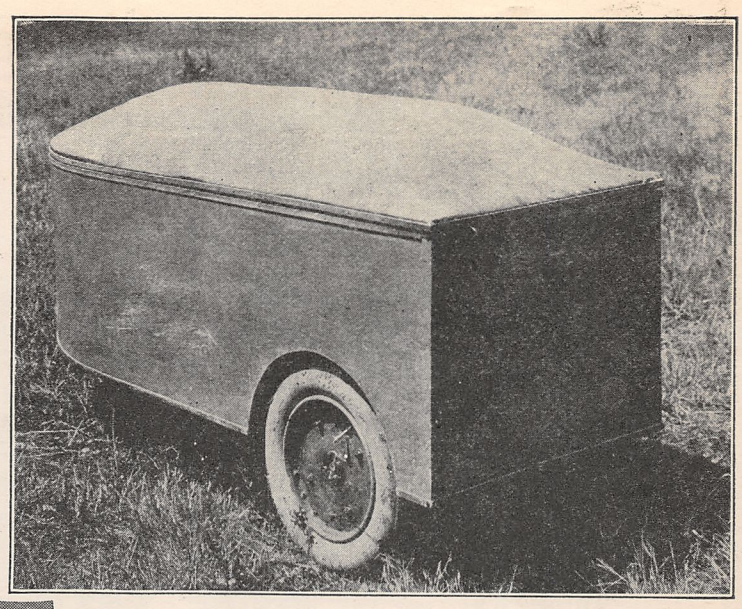
Relaying American Programs

In England, as well as in America, there are schemes afoot to rebroadcast programs from across the Atlantic. The technical arrangements are so promising that the British Broadcasting Company has been encouraged to set aside part of its time as "American Program Period."

McCook Field Radio Car

By A. M. JACOBS*

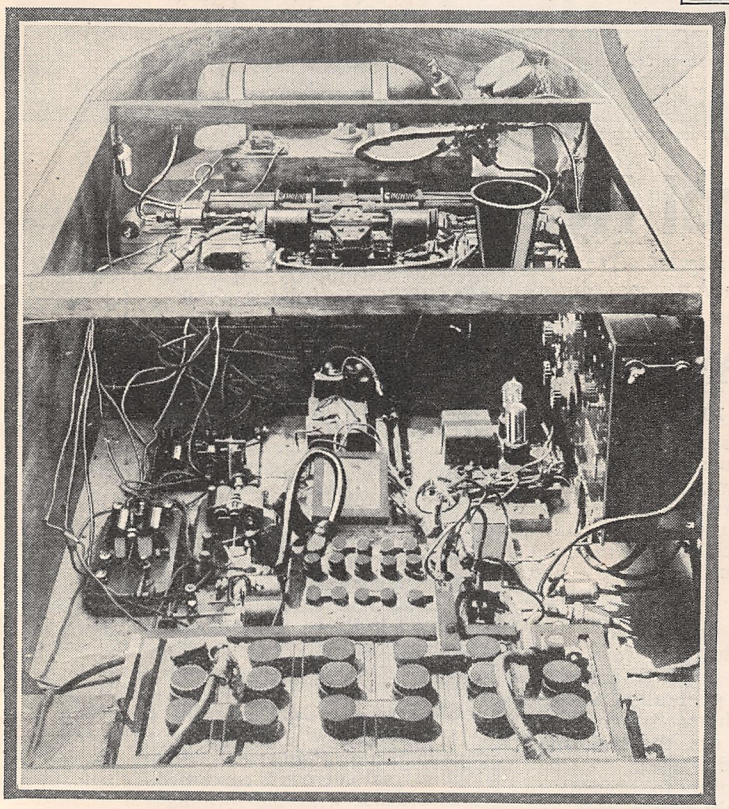
This is the only radio controlled car known to the author that responds instantly to any direction change or other control signal.



If you see a car resembling the one on the right meandering around the streets don't be frightened. It is only a radio controlled car guided by an airplane.

GHOSTS walk at McCook Field in broad daylight. Visitors to the Field on a recent occasion might have had every reason for so believing, for gliding about the flying field, sheeted in white, backing, going forward, performing "figure eights," moving sedately along the road or erratically forsaking it to follow some vagrant stroller across the green, roamed a low, strange object, scarcely human, without visible means of propulsion, and decidedly full of "pep."

But the age of the supernatural is passing and analysts would have discovered nothing more mysterious than the McCook Field radio car, white-covered in order to be visible from 2,000 feet in the air, where during two flights lasting an hour, Captain Murphy and Mr. Leland, in turn, kept its movements under perfect control by radio.



The installation in the radio-controlled car combines both radio and automotive apparatus. In the top of the picture can be seen the automotive machinery and the radio apparatus can be recognized in the foreground.

The radio car is an Engineering Division development, and for the past several years has been exhibited in various parts of the country, once having gone the entire length of Pennsylvania Avenue, Washington, D. C. Conrol heretofore had always been from an automobile which followed the radio car at a distance, or from a ground station. *This was the first instance where it was made to travel successfully by control from an airplane.* Tests from greater heights will be conducted in the near future.

It is of interest to know that a standard SCR-134 radio set was used as the transmission medium. The airplane was the Boeing metal DH4B. This car is the only one known of its kind in which the operation is selective, that is, it can be made to back, move forward, turn, blow a klaxon, etc., on the instant, at the will of the controller. It does not have to go through a cycle of set operations in turn. The development of remote control for war purposes is of too apparent advantage to need explanation, and the successful accomplishment of this test is but another step in the direction of such development.

Progreso De Esperanto, Lingvo De Radio

By JAMES DENSON SAYERS**

The following is a short statement which tells only in small part of the wide spread of Esperanto as the international radio language during very recent years. At the end of the Esperanto text below, will be found an English translation of the same, with a list of stations throughout the world which use or teach Esperanto.

DE la tempo kiam radio-telefonado ĉesis esti nura ŝatokupo en la manoj de amatoraj scienculoj, kaj fariĝis ilo en moderna civilizacio, ĝi estas estinta pli kaj pli videbla ke la helpo de internacia helpa lingvo devas esti uzata antaŭ ol la mirindaj eblaj disvolviĝoj de ĉi tiu nova scienco povas esti plene disvolvigitaj en vera internacia maniero. Ne vidante naciajn limojn, la hertzaj ondoj portas la homan voĉon super montojn kaj valojn, trans kontinentojn kaj oceanojn, sciante nur unu barilon, tiu de lingvo. Ĉi tiu barilo devas esti superigita se senfadenado estos fariĝinta vera ligilo inter la popoloj de la mondo, portanta la plej bonan kulturon de ĉiu nacio atingebla de ĉiuj.

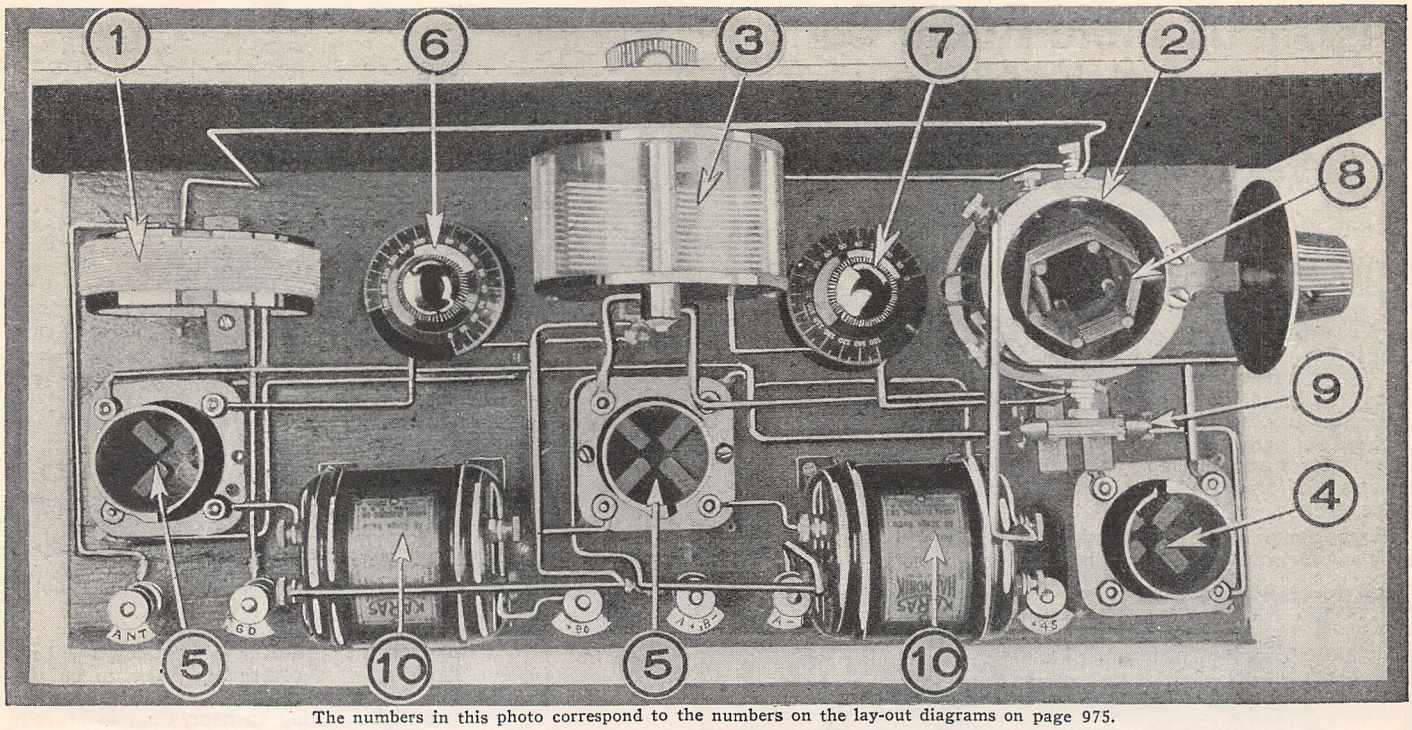
Komencante kun parolado de WJZ, Newark, 19an de junio, 1922, pri Esperanto kiel la venanta monda radio-lingvo, la nombro de stacioj disaŭdigantaj pri kaj per Esperanto estas kreskanta proporcie kun la pliiĝo en la nombro de stacioj. Kvin paroladoj pri Esperanto kaj unu kanto en tiu lingvo estis disaŭdigataj en Eŭropo kaj Ameriko dum 1922. Dum 1923 ĉirkaŭ kvindek tiaj detaloj estis en la programoj, pli ol ducent dum 1924 kaj dum la lasta jaro proksimume dudek stacioj sur ambaŭ flankoj de la Atlantiko estas disaŭdigintaj periode per Esperanto. Multaj stacioj estas donintaj lecionojn en la lingvo per la aero. Ĉe la fino de ĉi tiu artikolo listo de stacioj uzantaj Esperanton aŭ instruantaj ĝin estos trovata. Lastatempa sciigo de Germanujo diras ke ĉiu stacio en tiu lando nun donas semajnan programon en Esperanto. Ĉi tiu granda pliiĝo de intereso en Esperanto inter radio-rondoj estas grandparte rezulto de la rekomendoj de la Ĝeneva Konferenco dum, 1924.

LA ĜENEVA KONFERENCO

Prepara Konferenco por Internacia Interkonsento pri Senfadena Telefonado

(*Continued on page* 1026)

**United States Army Air Service. **President, New York Esperanto Club.*



The numbers in this photo correspond to the numbers on the lay-out diagrams on page 975.

A Single Control Regenerator

Froma well-known, though seldom used, mathematical formula to a novel set, which works entirely automatically, which solves a problem long confronting radio engineers, is the history of this new regenerator.

By SYLVAN HARRIS

AT LAST a *new* circuit has come to light—not one that is an old one in disguise, but one employing a principle that has not been utilized before.

The quest for an *absolute* single-control, non-radiating regenerative receiver has been going on for a long time, and a multitude of methods for controlling the tendency to oscillate have been proposed, but have not been found to be successful. It is true that self-oscillation in a regenerative detector can be prevented, but in all cases to date, this has been accomplished at the cost of reducing the amplification. The phenomenon is familiar to the owners of all so-called "self-neutralized" radio frequency amplifiers, which are built in so inefficient a manner that the regeneration never reaches the critical point. In these receivers the amplification is good on the shorter wave-lengths, but falls off considerably on the longer.

It is not necessary to go into detail concerning the evils of the radiating receiver. There is little doubt that every one of our readers have at one time or other, and in many cases, quite frequently, "cussed" that neighbor who constantly "bloops" and sends out his cat-calls just at the time all ears are focussed on the umpth symphony of Rubenthoven. But not only that, there is also to be considered the fact that when the detector tube is not operating near the critical point, the greatest possible efficiency is not being obtained. There have been various circuits proposed and tried out, combining the radio frequency amplifier and the regenerative detector, but wherever this has been accomplished considerable has had to be sacrificed for the purpose of obtaining stability of the circuits and ease of control.

The author of this article, like many others, has been working for a long time on this problem, and he is glad to present in this article a method that he believes is the most successful yet found. And more than this, the very simplicity of the method will no doubt surprise the reader.

Many circuits have made their appearance in the past few years under all kinds of high-sounding titles — which generally had no meaning. Furthermore, most of these "circuits" are the old time-worn standbys, disguised.

We are fortunate to present to our readers a truly new circuit, one that operates on a new principle, that is, a principle that has been known for a long time, but never found any application in radio receivers until Mr. Harris made the present one.

The simplicity of the whole thing is very surprising, considering all that the new circuit accomplishes. It not only furnishes us with a reliable means of controlling self-oscillation in a three-circuit tuner without allowing the amplification to drop on the longer wave-lengths but, at the same time, makes the receiver a true single-control receiver. All that appears on the panel of this receiver is one dial and one phone jack.

With the coming of this receiver the days of the "blooper" are over, and we can now listen in to beautiful symphonies without having them spoiled by all sorts of whistles and cat-calls.

—EDITOR.

THE LAWS OF REGENERATION

To begin with, it is necessary to know the laws controlling regeneration in the tube circuit. There are two ways in which regeneration is accomplished, *viz.*, by means of inductive feed-back (through a tickler coil) and by means of feed-back through the tube capacity. We shall consider only the first of these two ways in which regeneration is accomplished, for it can be shown that the method of controlling regeneration explained here will apply only to the case of feed-back through a tickler coil. No solution has yet been obtained for the other case.

It is well known that, due to the feed-back through the tickler coil, the effective resistance of the input (grid) circuit of the detector tube is reduced, and when the feed-back becomes sufficiently great, the effect is the same as if the resistance of the input circuit had been removed. We shall not consider the theory of the matter in this article for there are many diverse opinions on this subject. However, whatever the true explanation may be, the results are always the same, and it will be found that the *apparent* reduction of the grid resistance, as far as the signal current is concerned, is reduced in accordance with the formula

$$\Delta R = \frac{\mu M}{r_p C}$$

in which ΔR is the *reduction* in the resistance, μ is the amplification constant of the tube, M is the mutual inductance existing between the tickler coil and the coil in the input circuit, r_p is the internal output resistance of the tube, and C is the capacity in the tuned circuit connected to the input of the tube. These quantities are represented in Fig. 1. The derivation of the above formula is given by C. B. Jolliffe and J. A. Rodman in Scientific Paper No. 487 of the Bureau of Standards.

Now, if we consider that the setting of the tickler coil remains fixed, in other words, that we have a constant value of the mutual inductance between the tickler and the coil in the grid circuit, and that we have a certain value of inductance in the tuned circuit and a certain amplification factor in the tube, it can easily be shown that the reduction of the grid resistance is in accordance with the formula

$$\Delta R = k f^2$$

In other words, the apparent resistance of the tube input circuit is reduced in propor-

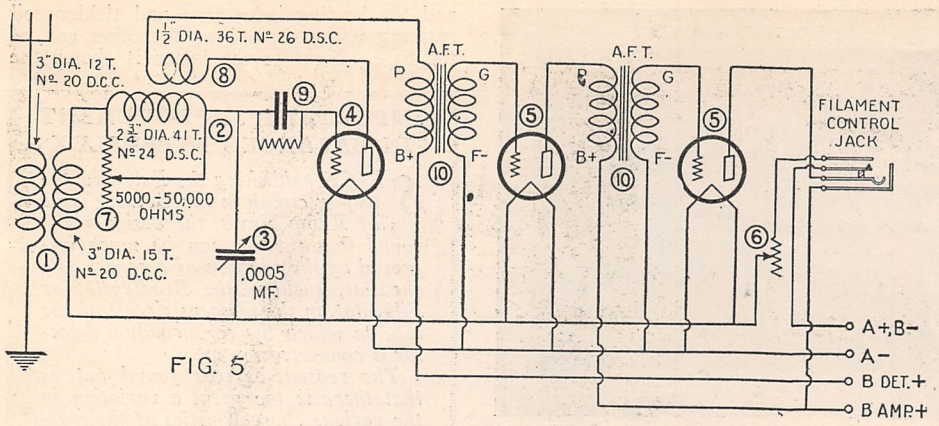


FIG. 5

1, Antenna and pick-up coils; 2, loading inductance; 3, variable air condenser; 4, detector tube; 5, amplifier tubes (201-A); 6, filament rheostat (6 ohms); 7, shunted resistance (5,000 to 50,000 ohms); 8, tickler coil; 9, grid leak and condenser (.00025 mf. and 2 meg.); 10, A.F. transformers.

tion to the *square* of the frequency.

Now, if we can obtain some means of increasing the resistance of the circuit *at the same rate* as it is decreased by the feed-back, it is evident that the apparent resistance will remain constant and the amplification will be the same for all frequencies or wave-lengths. This is what has been done in this method. A circuit arrangement has been chosen in which the apparent resistance of this circuit increases in proportion to the square of the frequency.

In other words, we have on the one hand, the tendency of the tuned circuit to *decrease as the square of the frequency,* due to regeneration, and on the other hand, the tendency of the special circuit to have its resistance *increase as the square of the frequency,* so that the net effect on the apparent resistance of the circuit is *nil.* Let us see how this is accomplished.

THE FUNDAMENTAL CIRCUIT

The fundamental circuit arrangement is shown in Fig. 2. Here we have a source of alternating voltage, shown in Fig. 2 as an alternating current generator, but which may be replaced by a coupling coil placed in inductive relation with a (primary) coil in the antenna circuit. In series with this emf. is a coil shunted by a resistance and a tuning condenser.

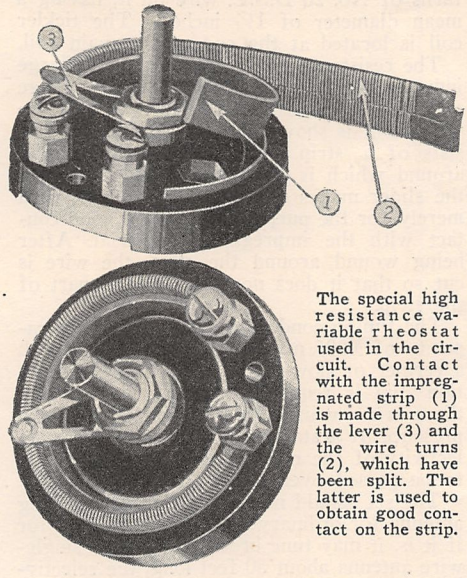
Now, if the impedance of that part of the circuit between the points A and B be derived, it will be found that the apparent resistance between A and B and likewise the apparent inductance will be different from the true resistance and inductance of the coil. For the sake of simplicity let us consider the case of a coil, the resistance of which is small compared with its reactance, so that its own resistance may be neglected.

The apparent inductance between A and B is changed only a very slight amount if the shunted resistance r is large, so that this effect will be neglected. Besides, the only effect this change of inductance would have would be to change the tuning slightly.

The apparent resistance between A and B (Fig. 2) on the other hand, changes considerably when r is connected across the coil, and it may either increase or decrease the apparent resistance, depending upon how large r is in comparison with the inductance L. The variation of the resistance is given by the formula

$$\Delta R = 0.0000\ 395\ \frac{f^2L^2}{r}$$

when r is very large. In this formula, f is the frequency in kilocycles per second, L is the inductance of the coil in microhenries,



The special high resistance variable rheostat used in the circuit. Contact with the impregnated strip (1) is made through the lever (3) and the wire turns (2), which have been split. The latter is used to obtain good contact on the strip.

and r is the shunted resistance in ohms. The way in which the apparent resistance changes as the shunted resistance r is increased is very interesting. This is shown in Fig. 3, which has been calculated for an inductance of 180 microhenries and a frequency of 750 kilocycles per second. When the shunted resistance r is less than a certain amount, the apparent resistance increases very rapidly as r is increased. After this certain value has been exceeded, the apparent resistance decreases as r is increased. This seeming paradox of decreasing the resistance of a circuit by increasing the resistance of a part of it, may trouble many of our readers, but it must not be forgotten that we have here a parallel arrangement of parts, *viz.,* a resistance in parallel with an impedance.

However, it will be noted that this applies only for a constant frequency. We are more interested in how the apparent resistance will vary with the frequency, for it is due to the increase of frequency on the shorter wave-lengths, that the circuits oscillate more easily on these wave-lengths. The formula given immediately above shows that, for given values of inductance and shunted resistance, the apparent resistance *increases* in proportion to the *square of the frequency.* This is the same rate at which the resistance *decreases* due to the feed-back, so that the two effects ought to annul each other.

This is exactly what happens, to a close approximation. There have been several approximations made in the theory, so that it cannot be claimed that the system works perfectly. Experiment shows that the increase of resistance is *not quite* equal to the decrease, so that there is a very slight decrease in amplification on the longer wave-lengths of the broadcast range. The decrease of amplification is small, however, and is not noticeable.

Let us now consider the application of these principles to the detector circuit obtaining regeneration by tickler feed-back. As has been intimated before, the generator shown in Fig. 2 may be replaced by a pick-up coil coupled to the antenna circuit. The inductance L in Fig. 2 therefore becomes a loading coil. The remainder of the circuit is the same as in any other three-circuit tuner. The final circuit, therefore, changes from the form shown in Fig. 1 to that shown in Fig. 4. The coupling between the tickler coil and the coil L remains fixed, the only variable instrument in the set being the tuning condenser C. It will be noted that this method, besides taking care of the regeneration automatically, at the same time furnishes us with a true one-control receiver.

To obtain such a condition that the increase of resistance is equalled by the decrease, or *vice versa,* it is evident that there must be a certain constant relation between the shunted resistance r and the mutual inductance between the tickler and the coil to which it is coupled. This relation is expressed as

$$r = \frac{K}{M}$$

where r is the shunted resistance and M is the mutual inductance. There is thus a certain amount of coupling required for a certain amount of shunted resistance. To adjust the receiver the shunted resistance is set at some convenient value, say about 25,000 ohms, and the tickler coupling is then adjusted so that the set operates just on the verge of oscillation. Theoretically this procedure should do the trick, no matter on what wave-length the adjustment is made or under what conditions, but on account of the approximations mentioned before, several trials may be necessary.

If it is found that the amplification drops off at the longer wave-lengths, the setting of the resistance should be changed a little and the tickler coil readjusted. If this does not do the trick another adjustment should be tried—and so until the best setting is obtained. After two or three trials it will be

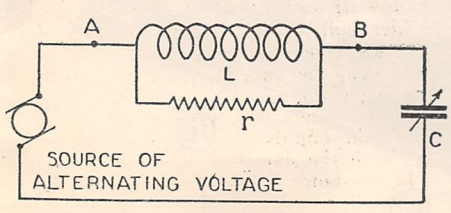


FIG. 2

The resistance of this circuit increases at the same rate as the input resistance in Fig. 1 decreases due to the regeneration.

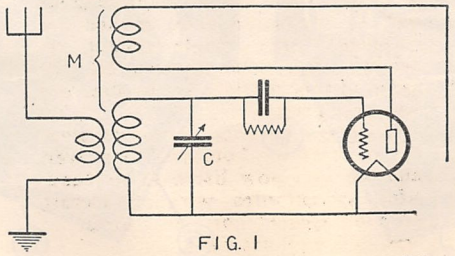


FIG. 1

The fundamental arrangement to accomplish regeneration by inductive feed-back (the three-circuit tuner).

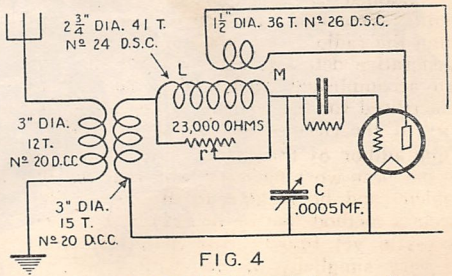
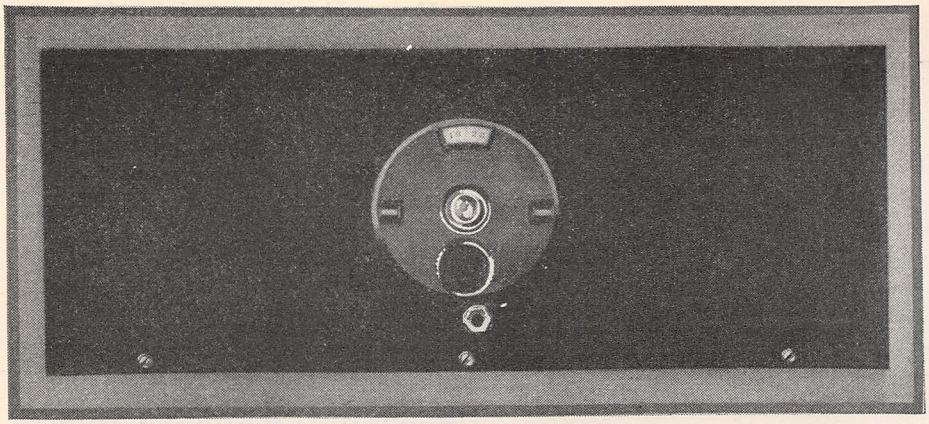


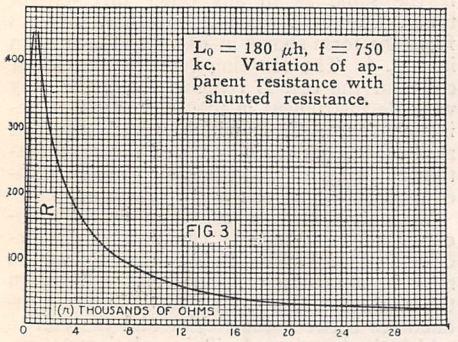
FIG. 4

Here is the final circuit evolved from those shown in Figs. 1 and 2.



The front view shows a true single-control receiver—merely one dial and a phone jack. Even the latter could be hidden by using tip-jacks in back of the panel.

found that the set can be operated without whistling and without decrease in amplification on the upper wave-lengths. The particular value of resistance required depends upon the way in which the coils are built. In the particular set described here, using 201A tubes, a .0005 mf. condenser and a standard coupler on the market, the best value for r was found to be 23,000 ohms.



This graph shows how the resistance between A and B in Fig. 2 changes as the shunted resistance is varied.

The complete wiring diagram is shown in Fig. 5. Two stages of transformer amplification are added to the automatically controlled detector. The various dimensions are given on the diagram. The pick-up coil consists of 15 turns of No. 20 D.C.C. wire wound on a 3-inch tube. The primary winding, to be connected to the antenna and ground, is wound immediately on top of the secondary or pick-up coil, and consists of 12 turns of No. 20 D.C.C. wire. The loading inductance, across the terminals of which is connected the shunting resistance was originally the secondary winding of a standard three-circuit tuner. The primary winding has been removed, as it is not needed in this circuit. The winding has a mean diameter of 2¾ inches and has 41 turns of No. 24 D.S.C. wire on it. The tickler coil has 36 turns of No. 26 D.S.C. wire on it, having a mean diameter of 1½ inches. The tickler coil is located at the end of the main coil.

The resistance used for shunting the large inductance is a special one, having a range of from 10,000 to 100,000 ohms. A close-up view of it is shown on these pages. It consists of a strip of impregnated material around which is wound a wire upon which the slider makes contact. This wire is used merely for the purpose of making good contact with the impregnated material. After being wound around the strip, the wire is cut so that it does not short-circuit part of the strip.

The tuning condenser has a maximum capacity of .0005 mf. and should be used with a vernier or slow-motion dial. The slow-motion dial is required, because when tuning there is no whistle to give evidence of the presence of a station and, because of the selectivity of the receiver, the station is likely to be passed over.

The set should not be used on a very long antenna for ordinary broadcast reception for if it is, it may tune broadly. With a single-wire antenna about 50 feet long, the selectivity is very good.

A filament control jack is used in the circuit and all that appears on the panel of the receiver are a single dial and a phone jack. The general arrangement of apparatus is shown in the photographs. The antenna coupling coil and pick-up coil, wound on the same tube, are at one end of the baseboard, and the loading inductance and tickler coil rotating within it, are at the other end of the base. Next to the latter is shown the variable high resistance, which is also shown in a separate photograph on these pages. The rheostat for controlling the filament

(*Continued on page* 1084)

IMPORTANT IMPROVEMENT IN BALANCED INTERFLEX

SINCE publishing the Balanced Interflex circuit in the October issue of RADIO NEWS, *the designer has found that the set can be much improved by the addition of a carbon pile rheostat, such as the Bradleystat or Filkostat, in the filament circuit of the tube to which the carborundum detector is connected.*

The reason, as was found out, is that there is too great a variation in the various characteristics of the crystal detectors, as well as the tubes, and in order to get the maximum results from the tube, it is necessary to adjust the filament voltage, which very often becomes critical.

The automatic resistance, while satisfactory in most cases, cannot do two things at once on this particular tube, and for this reason the carbon type rheostat has been found better on this tube. On the other tubes, the automatic resistances have been found highly satisfactory.

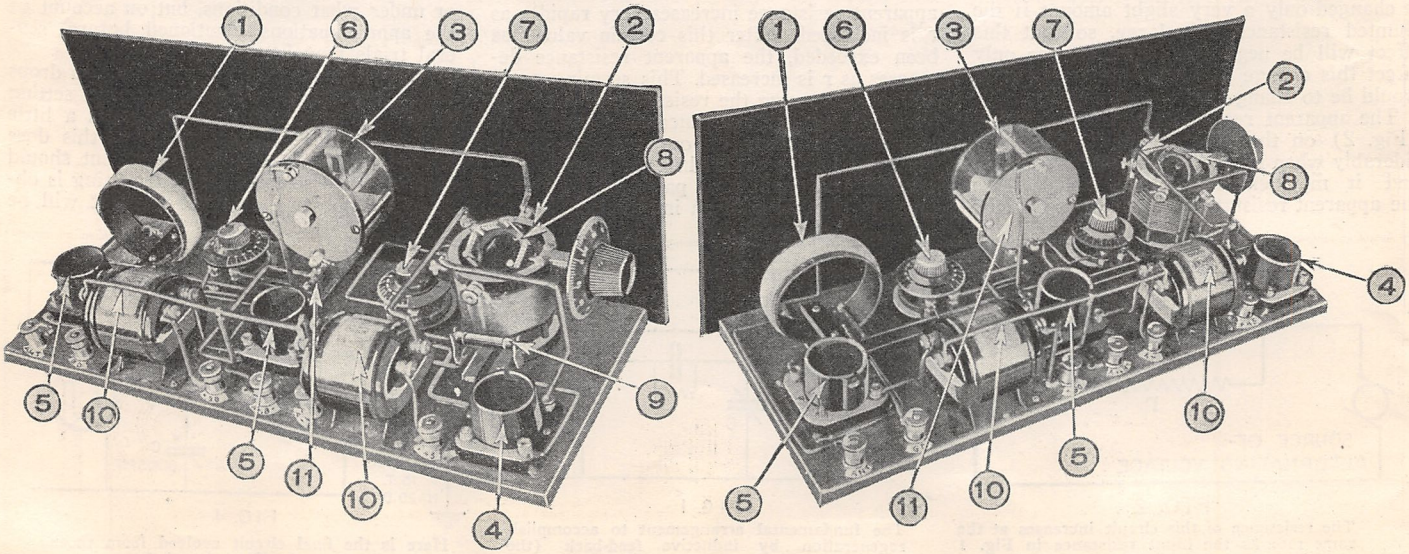
Some crystal detectors are so critical that the adjustment of the rheostat becomes very important, and for that reason a wire-wound type rheostat is not sufficiently fine, hence the reason for the recommendation of the carbon type is plain.

If, after installing the rheostat, the loud speaker emits a mushy sound, it shows that the crystal detector is overloaded. By putting more resistance into the circuit, that is, by unscrewing the rheostat knob, it will be found that this mushy sound soon disappears and that the reproduction of the broadcast sounds become exceptionally clear.

If too much resistance is used—if the tube does not light up enough—the volume tends to decrease.

The rheostat should be mounted behind the panel, as once the crystal detector is adjusted to its tube it need never be touched again.

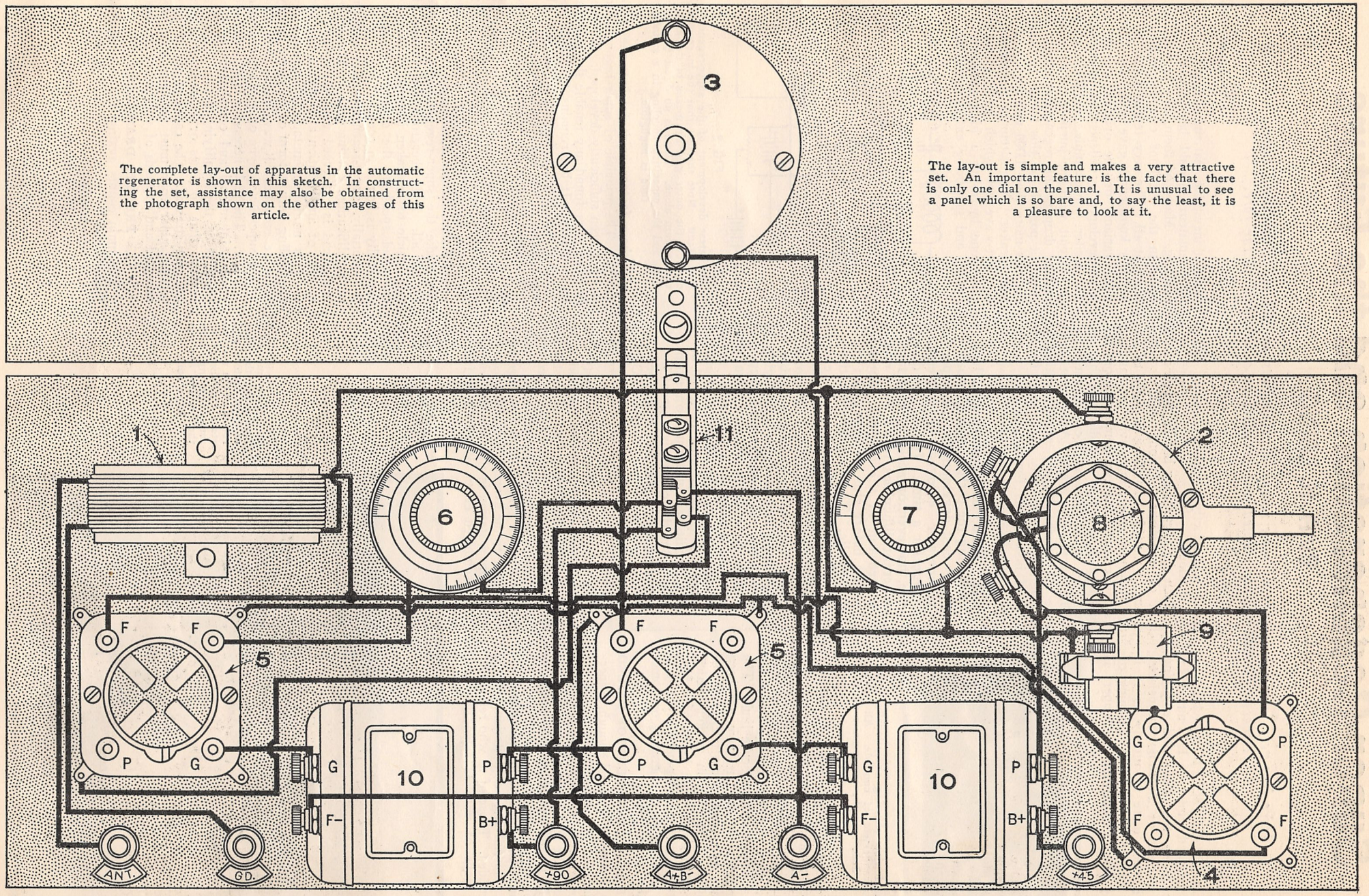
The same procedure was found necessary in the REGENERATIVE INTERFLEX described in the December issue.



Two back views of the receiver. The numbers in these photographs correspond to those on the large lay-out diagram on page 975.

The complete lay-out of apparatus in the automatic regenerator is shown in this sketch. In constructing the set, assistance may also be obtained from the photograph shown on the other pages of this article.

The lay-out is simple and makes a very attractive set. An important feature is the fact that there is only one dial on the panel. It is unusual to see a panel which is so bare and, to say the least, it is a pleasure to look at it.



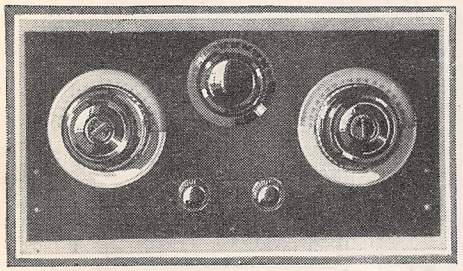
1, Antenna and pick-up coils; 2, secondary loading inductance; 3, variable condenser (.0005 mf.); 4, detector tube (201-A); 5, amplifier tubes (201-A); 6, rheostat controlling all tubes at once (6 ohms); 7, high resistance rheostat, used for shunting secondary loading inductance; 8, tickler coil; 9, grid condenser (.00025 mf.) and grid leak (2 megohms); 10, acdio frequency transformers; 11, single circuit filament control jack.

Super-Regeneration and the Future

By A. K. LAING

Here is a very interesting study of some recent developments in the old Armstrong Super. It was never thoroughly studied and promises to come again to the fore.

SUPER-REGENERATION, which, in the fall and winter of 1922 and 1923, was filling the minds and emptying the pockets of all radio enthusiasts, today is ignored quite as utterly as if it had never existed at all. The reasoning of the radio public in discarding the "super" is



Front panel view showing exceptionally symmetrical arrangement of controls. All actual tuning is done with the two vernier dials.

perfectly sound. It was widely tried out, and proved unsatisfactory in the vast majority of cases. It assumed the proportions of a nine days' wonder, and, together with other nine days wonders, on the tenth day wended its way to some obscure limbo. The few super-regenerators that have not been pulled apart to salvage some useful instruments are now reposing in various attics, garnished with appropriate knots of crêpe. Fandom turns to the super-heterodyne, and a host of other "dynes" operating on somewhat similar principles.

WHY THE SUPER-REGENERATOR FAILED

All this, I repeat, is logical enough. Super-regeneration did not satisfy, and the super-heterodyne does. Yet, the writer feels quite safe in asserting that super-regeneration has been vastly more "sinned against than sinning." Super-regeneration has failed, not through any inherent flaw in theory, but because of criminal over-exploitation of the germ of an idea. Those of us who remember the early days of wireless telegraphy can recall a perfectly parallel case of over-exploitation.

Much the same thing has happened in the field of super-regeneration. Major Armstrong, a wizard at handling any type of set, and the most expert man living at handling his new circuit, gave two demonstrations before prominent bodies of radio men that set the radio world agog with excitement.

The parts that Major Armstrong used were all of the highest grade obtainable, although not necessarily the most efficient kind of instruments for use in such a set.

A COUPLE of years ago, during the early stages of broadcast development, the super-regenerator enjoyed an extreme vogue for a time. It fell into disuse, however, on account of certain inherent difficulties which were not ironed out in the original experiments before the set was given to the public. The fact remains that the "super" gives extremely efficient use of tubes.

Herewith is presented a new form of the "super," one using a double-grid tube and another employing two tubes. The double-grid circuit, it must be said, necessitates a really good double-grid tube, such as those used by the Marconi Company. The tubes must be good or the circuit will not function properly. But the circuit is a great improvement over the previous supers.

—EDITOR.

On the other hand, most of the parts sold for use in supers were of the same kind as those used by the Major, but of vastly inferior quality. Also, it must be noted that the original demonstration set used power amplification at a much higher voltage than is available to the average fan, and was operating from a station in the immedite vicinity.

The combined effect of all these factors made it inevitable that the sets made up by most amateurs should be distinctly disappointing. Many of them, due to worthless parts in the oscillator circuits, would not work at all. The very few sets that, in the writer's knowledge, gave some satisfaction, were variants of the original circuit, and were developed by independent investigators. The writer, for example, modified the original circuit with the purpose of minimizing voltage drop in the regenerator circuit, and found it possible by this means to bring in stations more than 1,000 miles away on the loud speaker. An amateur in Maryland made a short-wave set which gave remarkably pure tone by using a high variation frequency and sacrificing extreme volume.

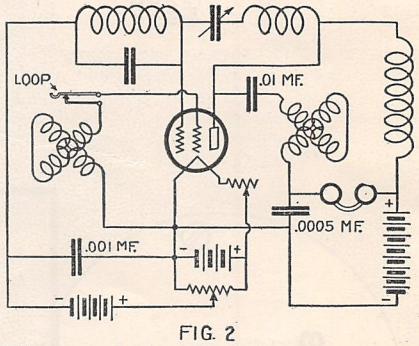


FIG. 2

The latest development of the super-regenerative circuit. Note the fact that the inner grid controls the outer grid by means of the electron stream alone. There is no direct connection, and the capacitive coupling in a suitable tube is negligible.

All these factors point to but one conclusion. The principle of super-regeneration has not been sufficiently developed. No one, however, has found any tenable flaws in the basic theory. It but remains to design apparatus, and circuits, in which the idea of super-regeneration will function properly.

The super-heterodyne, impractical for general use in its original form, has seen modification and development over a period of years that now make it a practical set for anyone to own. The writer believes it inevitable that similar development will some day make the super-regenerator a suitable set for all. It is, therefore, the purpose of this article to reawaken interest in the circuit, and speed up the development which eventually is bound to come.

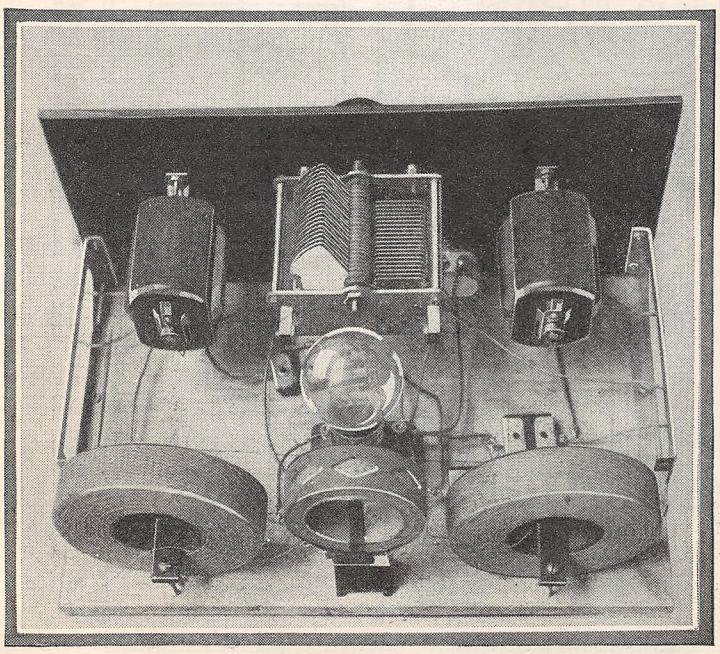
Essentially, super-regeneration is a form of amplification, nothing more. The problem ahead is concerned with purifying this method of amplification and such a problem presents no insurmountable obstacles. We are dealing with a form of pulsating energy of more complicated wave form than that of the super-heterodyne or any other simple receiver. The task necessary is to apply the various intentional and complementary frequencies of the amplifying device in such a manner that no tones or extraneous noises are over-stressed. The cause of the characteristic super roar must be more carefully analysed and methods of prevention devised.

PRESENT DRAWBACKS

The main counts against the conventional "super" may be enumerated as follows:

1. Limited range.
2. Undesirable extraneous noises.
3. Distortion.
4. Broadness of tuning.
5. Expense of maintenance.

Let us examine these, one by one.



Back view of the laboratory model. Notice that the fields of both stators and rotors of the variometers are always at zero coupling with the fields of the two large coils.

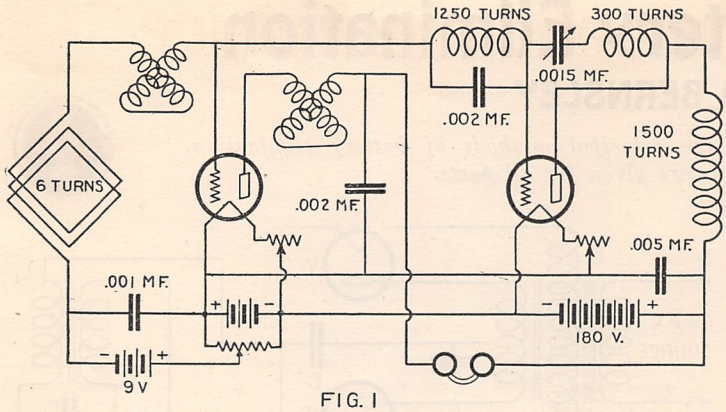


FIG. 1

This circuit was the writer's first development of the original Armstrong arrangement. A substantial reduction in grid shunt capacitance allows the use of tuned plate regeneration in place of tickler.

The first count is completely refuted by the performance of the modified super-regenerative hook-up developed by the writer and shown in Fig. 1. Losses in the Armstrong condenser-tuned model concentrate in the grid circuit of the first tube, before the process of super-regeneration has any chance to take effect. A tangible signal must first reach the grid of the initial tube in any circuit before the circuit can be expected to function. With a loop instead of an outdoor aerial, an inefficient shunt coil, and a still more inefficient shunt capacitance of very high value—all placed across the grid of the first tube (which is in most cases the detector)—there is little wonder that only the signals of powerful local stations could be heard.

But in the circuit of Fig. 1 these disadvantages are eliminated. The only capacitance across the grid is the negligible distributive capacitance of the loop and the variometer. The capacitance of the oscillator circuit, apparently in shunt with the grid of the first tube, is made ineffectual by the high frequency choke system between grid and plate of the oscillator tube.

In this manner, by substituting inductive tuning for capacitative tuning, incoming signals suffer a much lower voltage drop, and the range is vastly increased. The writer has repeatedly received stations in Cuba, Kentucky, Chicago, and some even farther away, in Hanover, N. H., and with loud speaker volume. This seems to dispose rather effectively of the first objection. The super can have as great a range as any other set when the same respect is paid to the merest fundamentals of radio engineering practice in general.

THE PRINCIPAL OBJECTION

The second objection is the main stumbling block. The super is laden with extraneous noise, part of which is as yet unexplainable. When signals are strong enough, the other noises become insignificant, or are drowned out. But with a moderate signal the noise of even a well-made super is bad enough to spoil the average listener's appreciation of the concert. These extraneous noises fall under two general heads, (1) The note and harmonics of the oscillator, and (2) the characteristic "super roar."

The harmonics of the oscillator are not very bothersome, as they are extremely sharp, and only occasionally heterodyne with an incoming station. The fundamental frequency of the oscillator can be raised above audibility, in the well-made set, without sacrificing too much volume to make the use of this circuit less desirable than the use of another on that count alone.

The characteristic roar is harder to combat. No one, to my knowledge, has given a completely satisfactory explanation of the cause of this roar, which corresponds in apparent effect to the "clicking point" at which the ordinary regenerative set breaks into oscillation. If all the instruments are of the highest quality obtainable, and leakage paths are eliminated, this roar is restricted to a small area on the dial—not over 5 or 10 degrees at the most. But, unfortunately, the point of greatest amplification seems to come very near the center of that "roar area" on the dial. A remarkable amount of amplification can be obtained by staying below the lower limit of the roar area, but not enough to warrant the use of the super, as more satisfactory results of a like nature can be obtained from other circuits of about the same cost, if we average original purchase price and upkeep.

The big problem seems, therefore, to be the condensation of this roar area to a single click like that of a regenerative set. It is the writer's opinion that this will come about only when a tube is designed for use in this specific circuit alone.

The third main objection mentioned above, distortion, can be eliminated to a considerable degree by intelligent design, and by the proper regulation of grid potentials. Distortion in the super is not comparable to that of ordinary amplifying devices. It is almost entirely due to uncontrolled surges of power building up the signal strength, or bucking it, as the case may be. The writer's experiments have led him to believe that the super principle is capable of amplification with less distortion than one gets with comparatively good amplifying transformers. It is the spontaneously generated power at or near the roaring area that causes most of the distortion. The solution to the second objection will, therefore, contribute to the solution of the third.

The fourth point, broadness of tuning, is not at all as troublesome in the super-regenerator of Fig. 1 as it is in the original Armstrong circuit. This may be due to the elimination of the shunt inductance circuit of loop and grid coil. It is also due, in part, to the careful adjustment of the filter circuit after a station is tuned in.

The fifth point, nowadays, may be almost disregarded. It was something of a bugbear a few years ago to think of maintaining nearly 200 volts in "B" batteries. Now that is taken care of by the numerous battery eliminators, some of which will deliver 250 volts or more.

Aside from this feature, maintenance is low. Only one-half the number of tubes are used to achieve results equivalent to five- or six-tube sets.

In reviewing the detailed inspection of these objections to the super (and they are all the objections that a questionnaire sent to a dozen former users of the circuit brought forth) it is apparent that No. 2 is the most serious. It is, in fact, the only one that is at all serious. No. 1 is eliminated in the circuit of Fig. 1. No. 3 is greatly reduced in this circuit, No. 4 is somewhat reduced, and today No. 5 may be left out of the argument, for the expense is no greater than that of any neutrodyne or super-heterodyne using large tubes.

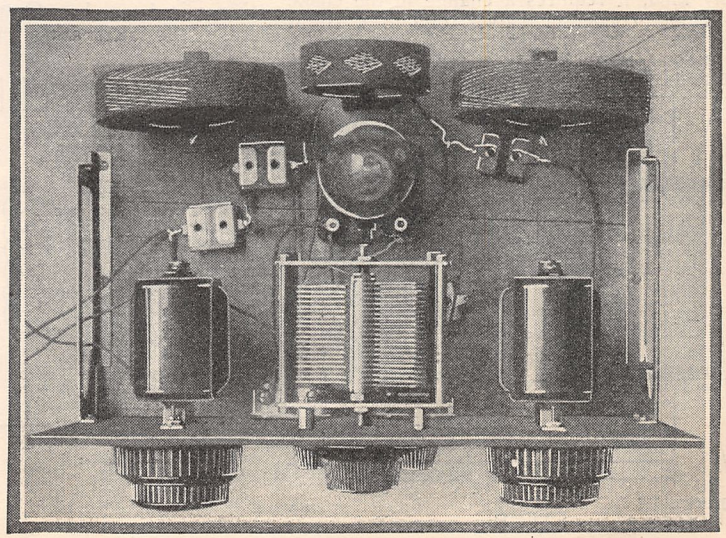
This inspection makes it evident that the substitution of inductance tuning, and the elimination of the tickler coil in favor of tuned plate regeneration is a long step in the right direction. The writer first announced this improved circuit a little over two years ago. He received scores of letters from builders of the set, most of whom reported success.

It was still very apparent, however, that the undesirable noise element had not been decreased. And this feature was enough to kill the improved circuit, as well as its less efficient predecessor. Even after the whole furore that had centered about super-regeneration was at last silent, the writer continued experimenting with the circuit, and by such artificial means as filters and leakage shunts succeeded in making the set somewhat more quiet in its operation. But it was always apparent that these measures were superficial, just as was the complicated filter system on the original Armstrong set. The need was more for a fundamental change in the circuit that would subdue the extraneous noises at the source.

No success at all was achieved in this, so the work was laid aside for over a year. Recently, however, a chance inspection of the circuit gave rise to an idea that, it seemed, might prove the complete solution of the problem.

A glance at Fig. 1, or at the original Armstrong circuit, will show that the tuned grid circuit of the first tube—that is, the portion of the circuit that is attuned to incoming oscillations—is completely shunted by the very complicated oscillator system. This may be taken to account for broadness of tuning, and for the instability of the point at which the circuit breaks into oscillation. Yet it is necessary to vary the potential on the grid by means of an oscillator, in order to produce the super-regeneration effect.

(*Continued on page* 1040)



A comparison with Fig. 2 reveals the fact that the arrangement of parts shown in this top view is really the most efficient possible. Nothing is sacrificed to "good looks."

Methods of Battery Elimination

By JOSEPH BERNSLEY

This article gives a complete description of the principal methods of battery elimination. Full constructional details are given for all parts.

IN considering the problem of eliminating either "A" or "B" batteries, or both, in connection with radio, we must resort to a thorough study of the probable sources and methods of substitution. There may, in all likelihood, be developed a tube which will not employ filament and plate batteries, but it is improbable that such a development will take place in the near future. We must, therefore, of necessity, consider the house lighting supply, as so far the only practical means of obtaining a current that will be dependable in the sense that there is no running down or discharged condition.

Were there a uniform current supply all over the country, the problem would be very much easier than it is. This article would then consist of one simple circuit diagram of the eliminator with a list of the apparatus used and their values. It is well known, however, that some sections have direct current, some alternating current, either 60-cycle, 25-cycle or 40-cycle, and some have a 32-volt lighting supply (farms). It is also well known, to engineers especially, that where an eliminator working on 60-cycles, for example, works smoothly without a hum of any kind, it requires a change in the choke coil and condenser valves, due to a slight variation in the current supply, for use in some other place where the current is supplied by another generator or company.

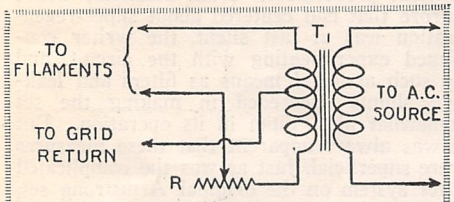


FIG. 2

This figure shows filament supply from an A.C. source without rectification. The center tap on the transformer aids in neutralizing hum effect.

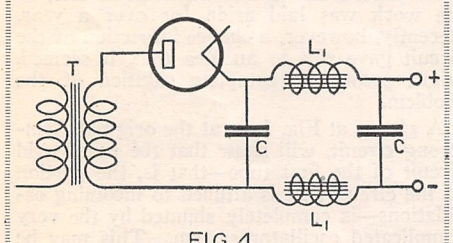


FIG. 4

The principle of a half-wave rectifier. This is not quite as efficient as the full-wave rectifier.

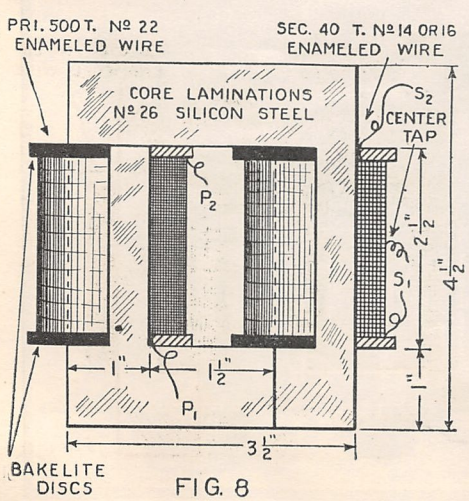


FIG. 8

Fig. 1. Circuit on the right indicates how A.C. may be used to light the filaments without rectifying or filtering it.

Fig. 8 shows a design of a step-down filament transformer delivering a large current at 8 volts.

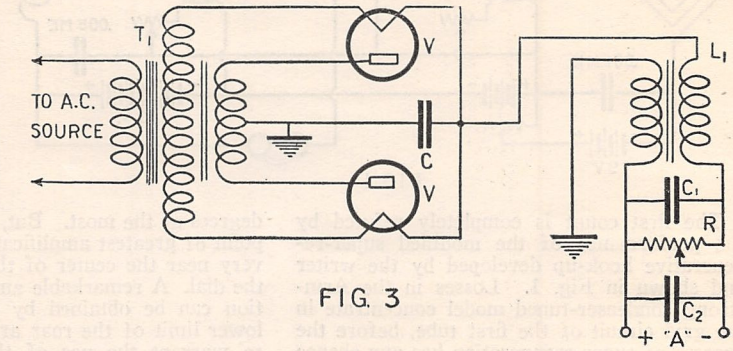


FIG. 3

Full-wave rectifier delivers "A" battery voltage. The slider arm on R controls the voltage output.

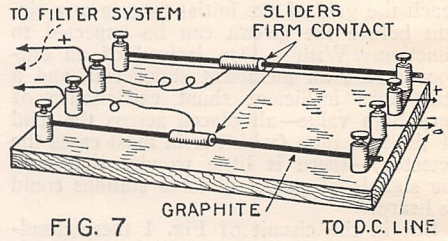


FIG. 7

D.C. resistance unit for filament supply employing ordinary pencil graphite for resistance.

ELIMINATION WITH ALTERNATING CURRENT

Alternating current has been used (without first rectifying it) to light the filaments of receiving tubes with some fair success by experimenters. Figs. 1 and 2 are examples of circuits that permit the use of A.C. for filaments. It is, of course, understood that the voltage must be reduced to the voltage rating of the manufacturer of the tube, or somewhat in excess of this voltage. This is accomplished by means of a step-down transformer, the secondary winding of which has a mid-tap. An ordinary filament transformer with secondary center tap used by amateurs for transmitting tubes will be satisfactory for this purpose. It must be remembered, however, that although reception is possible with this method of battery elimination, the alternating current hum will prevail throughout.

For absolutely smooth reception, the A.C. must be first rectified and filtered. Figs. 3, 4 and 5 illustrate various means of accomplishing this. Fig. 3 shows a rectifier that rectifies both sides, or waves, of a cycle, reducing waste and resulting in a fairly smooth direct current. Fig. 4 shows a rectifier that operates on one side of the cycle and is technically termed a half-wave rectifier.

In all these circuits, although the two-element rectifying tube is shown, the standard audion (three-element tube) used for receiving purposes may be used with just as great efficiency. The grid and plate are then wired together. Graph A shows graphically the alternating current before and after rectification pulsating to D.C., and after being filtered to obtain pure D.C.

Where "A" battery elimination with a D.C. supply is desired, an arrangement such as shown in Fig. 7 will work very efficiently and satisfactorily, especially when carefully built and adjusted. The output of this resistance unit, when properly filtered, is an ideal "A" battery substitute, and can be built at an exceedingly low expense.

"B" BATTERY ELIMINATION

In the design of an eliminator or substitute for "B" batteries (dry-cell type, or solution type) for receiving purposes, there can be no compromise such as shown in Figs. 1 and 2 of "A" battery eliminators. Also the current obtained must be entirely smooth, the slightest ripple having a disastrous effect on the reception obtained, especially where weak signals are concerned. The plate of the receiving tube must have a constant positive potential that does not vary in the slightest degree. Some battery eliminators on the market now are inefficient because of their failure to meet this requirement.

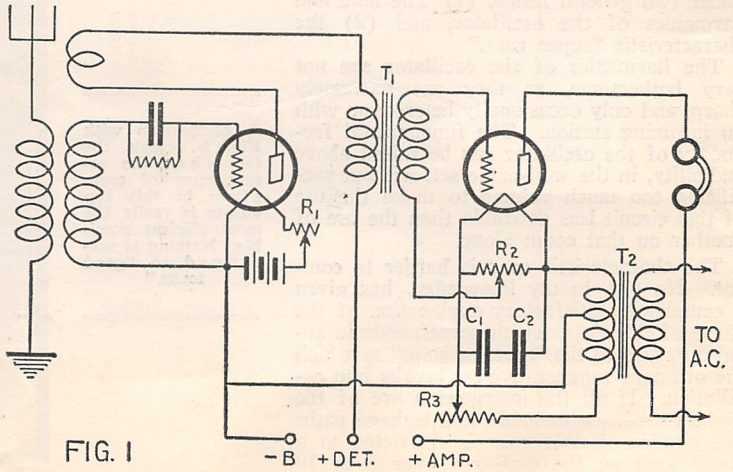


FIG. 1

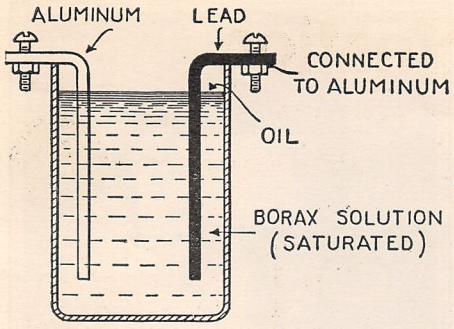
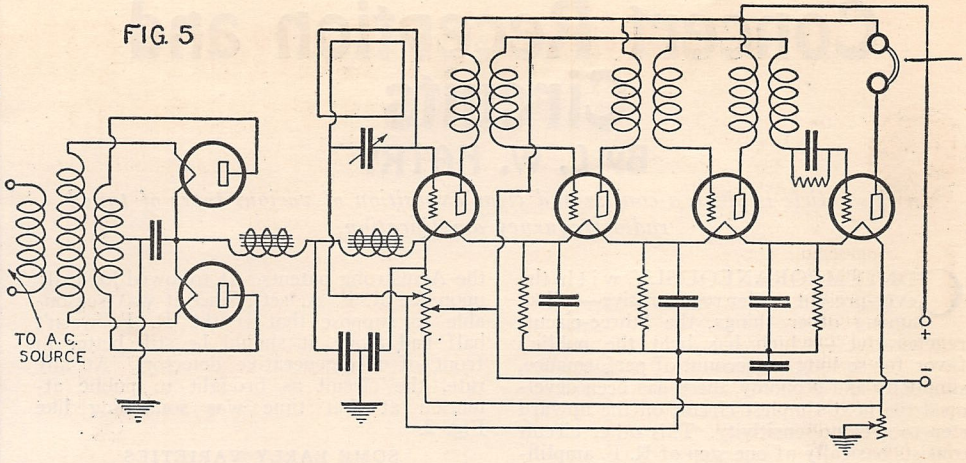


FIG. 14

Here is shown the construction of a chemical rectifier unit. Ordinary house borax may be used.

FIG. 5



This circuit illustrates a receiver and "A" eliminator combined. Condenser values are 2 mfd. each.

Transformer design (for use with A.C. supply) for a "B" battery eliminator is entirely different from that used in connection with an "A" eliminator. A much higher voltage is required; in fact, a step-up transformer must be used to compensate for the voltage drop due to rectification, and across filters, whereas a step-down ratio was used in the design of the filament transformer. Then, again, the current necessary in the output of the plate voltage transformer is not 1/25 as great as that necessary from a filament transformer, being, at the very most, 50 milliamperes, whereas from 1 to 2 amperes is required from the latter transformer.

Figs. 8 and 9 show the design of both types of transformer, including specifications. The filament transformer consists of a primary and secondary winding, the primary having approximately 500 turns of No. 22 B.&S. gauge enameled covered wire, the secondary 40 turns No. 14 enameled wire. The windings are wound upon a laminated core of iron or silicon steel, preferably silicon steel (No. 26). Core dimensions are 2½ x 1½ x 1 inch cross-section. The output of this transformer, delivering about 4 or 5 amperes, will be capable of taking care of a super-heterodyne set.

Fig 10 shows the design of a transformer that has both filament and plate voltage windings on a common transformer core. The primary consists of 330 turns No. 14 enameled (B.&S. gauge) alongside of which is wound (see illustration) the filament winding consisting of 24 turns of a very heavy copper ribbon about 3/16 inch in width and well insulated with a tape or enamel covering. The filament winding may be used to light the rectifying tubes or, after rectification, for receiving tube filament. A high tension side is wound with 650 turns No. 28 enameled wire. The core dimensions are 4x2½x1 inch cross-section.

Fig. 11 illustrates the design of a 10-henry choke coil. Specifications are given in the illustration. The choke coil is used to smooth the pulsating D.C. to uniform flowing D.C.

Fig. 12 shows a means of connecting up a "B" eliminator with suitable means of providing a detector plate voltage, besides high voltage for amplifiers.

Fig. 13 illustrates a rectifier system using chemical rectifiers which are extremely efficient and inexpensive. Radio operators of amateur stations have long been using this method of obtaining "A" and "C" plate voltage, where the house lighting source was A.C., with extremely efficient results.

Fig. 14 illustrates the design of a chemical rectifier. It consists simply of pure lead and aluminum plates placed in a jar within which is a saturated solution of water and borax (ordinary cheap house borax will do). A thin film of oil is placed on top of the solution to retard evaporation.

In Fig. 15 we have a "B" battery substitute working from a direct current source. The materials needed are few, no rectification being necessary, and the current obtained after filtering being a smooth D.C. Provision for detector plate voltage is also made.

Thirty-two-volt lighting sources (farm lighting systems) may be used for filament lighting by wiring the filaments of the tubes in series. Where three tubes are concerned a 30-ohm rheostat wound with a heavy resistance wire of many turns is required to handle the surplus E.M.F. An ordinary 10-ohm rheostat will suffice for a 5-tube set.

Here is shown a method of connecting filaments and using rectifier for the filament source. A filter system may be necessary.

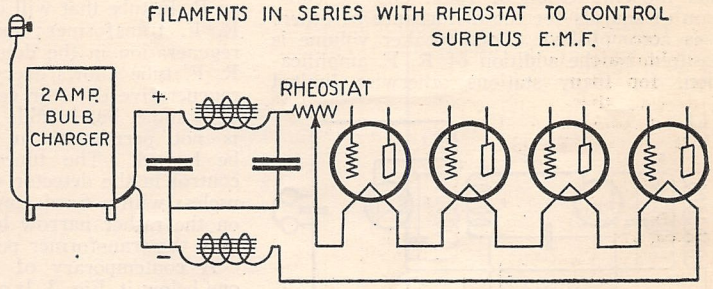


FIG. 16

BUILDING AN ELIMINATOR

The experimenter, if mechanically inclined, could secure a second-hand motorcycle or Ford generator and couple it to a fairly strong motor, the speed of which is approximately that required by the generator to deliver 8 to 10 volts. A well-constructed coupling should be used; a simple and efficient one consists of a spiral spring, one end of which is attached to the shaft of the motor. However, the better the coupling system the smoother and less troublesome the unit will be.

A 2-ampere Tungar charger can be used for "A" battery supply, if the output is filtered with chokes and condensers and the filaments of tubes in the set wired in series (Fig. 16) with a rheostat to control the surplus energy.

The battery eliminator builder is advised to insert a .006 mica fixed condenser in series with the ground lead going to his set to prevent possibilities of a short circuit of the

(*Continued on page* 1064)

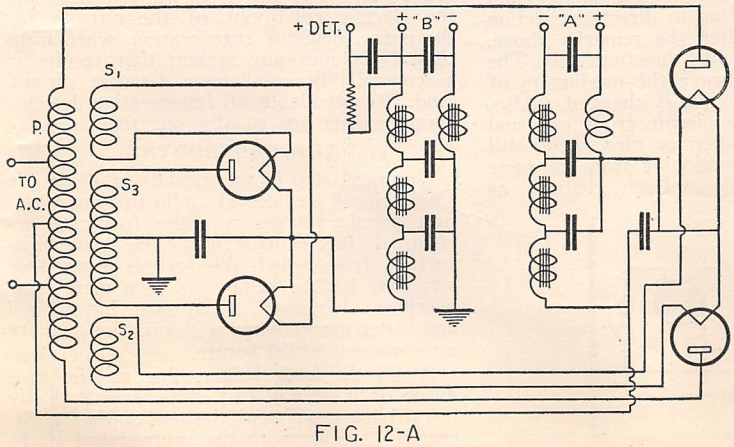


FIG. 12-A

"A" and "B" eliminator from A.C. source. The by-pass condensers have a value of 2 mfd. each. The choke coils, approximately, are 5 henry each.

Design of a step-up transformer for "B" eliminators. Dimensions for core are the same as shown in Fig. 8. Silicon steel laminations should be used.

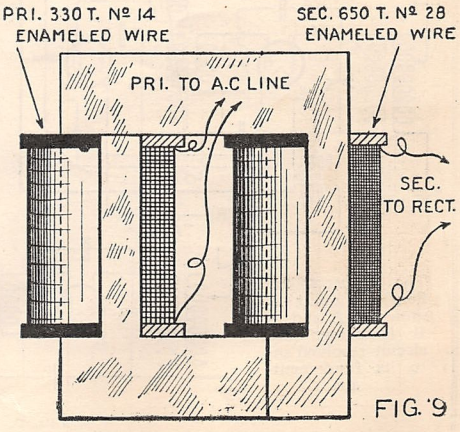
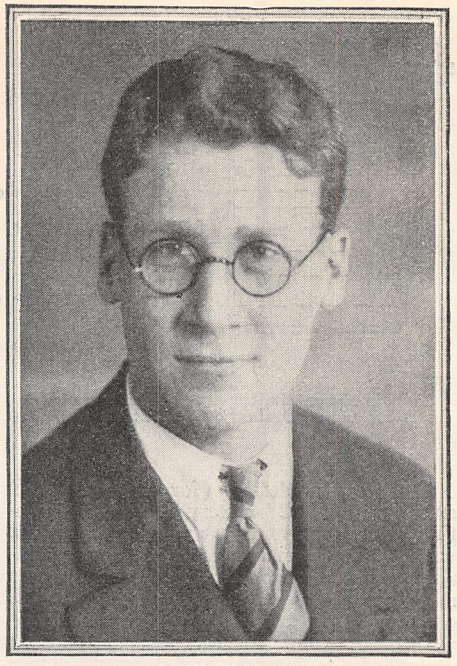


FIG. 9

Concert Reception and Circuits

By L. W. HATRY

In this article is given a concise and clear exposition of various types of tuned radio frequency amplification.



L. W. HATRY

CONTEMPORANEOUSLY with the ever-present tickler regenerative—called, among other things, the "three-circuit regenerative"—which has held the public's favor for so long on account of performance, simplicity and economy, there has been developed the next simplest circuit on the upward step to greater sensitivity. This other circuit consists basically of one step of R. F. amplification, plus a regenerative detector. This arrangement, like the single-tube regenerative, has been designed and redesigned unendingly. It has become popular for two reasons: more consistent response is obtainable than from the regenerative detector unassisted, and the elimination of radiation—the emission of squeals for the disturbance of others—is accomplished. Loud-speaker volume is assured, by the addition of R. F. amplification, for many stations otherwise limited

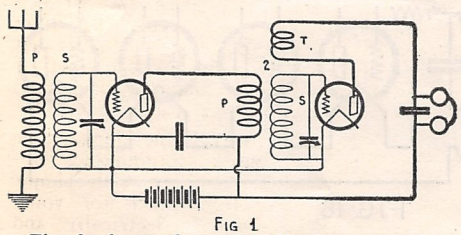


FIG 1

The fundamental tuned radio frequency circuit is the one on which the circuits following are based.

to the head-phones in spite of normal audio amplification. And there will be no radiation provided some trick is used to guarantee a non-oscillating condition in the R. F. stage. Any time an R. F. tube which is coupled to the antenna is allowed to oscillate, it is most probable that the set is also transmitting.

THE BASIC CIRCUIT

The basic circuit which we are discussing in this article is shown in Fig. 1. Nothing is indicated for tuning, since this is the fundamental diagram, the skeleton of all the others to be mentioned.

Its first appearance was sufficiently long ago to be out of the bonds of easily corroborated dating. However, its practical appearance was immediately following the first craze that sold and oversold all the sets produced—the craze that produced stacks of single-circuit regeneratives and R. F. amplifier sets designed to circumvent the Armstrong patents. It followed logically upon the R. F. A. sets, since it was reasonable to suppose that if the R. F. wasn't half bad alone, it should be still better in front of a regenerative detector. At any rate, the circuit as brought to public attention at that time was something like Fig. 2.

SOME EARLY VARIETIES

This circuit (Fig. 2) consists of one stage of R. F. amplification using a fixed, tuned transformer and a regenerative detector, regeneration being supplied and controlled by a plate-variometer. The circuit has several things wrong with it: an R. F. tube that will oscillate; fixed, tuned R. F. transformer; and somewhat useless regeneration in the detector. An oscillating R. F. tube allows every advantage that the regenerative detector could give in the way of volume, but it adds noise to the air and is not permanent in calibration—it can't be logged. The tuned plate regeneration control in the detector circuits is practically useless with a fixed, tuned transformer, save on the rather narrow band of wave-lengths near the transformer peak.

A contemporary of this circuit was the one below it, Fig. 3. It also has an oscillating R. F. tube and hence no need for regeneration in the detector. It is better than the foregoing circuit, since the R. F. choke, furnishing the plate impedance of the amplifier as well as the detector grid-circuit, is tunable. Oscillation is controlled by this

This circuit has several drawbacks. The R.F. tube has no means of preventing oscillations and the regenerative properties of the detector circuit are more or less useless.

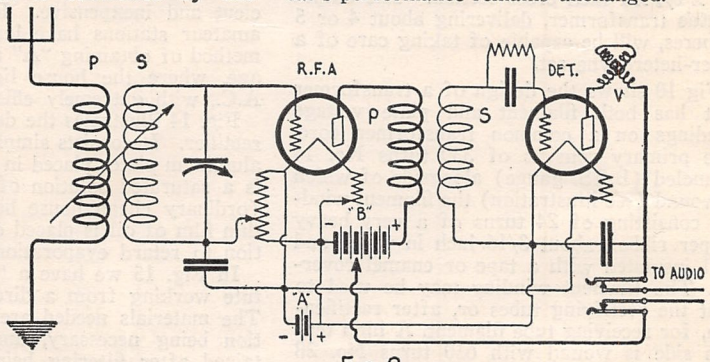


FIG. 2

plate-choke, so no potentiometer is used or needed. The circuit radiates, which is its real disadvantage. Again the uselessness of the detector plate variometer holds true because regeneration is already present in the R. F. tube.

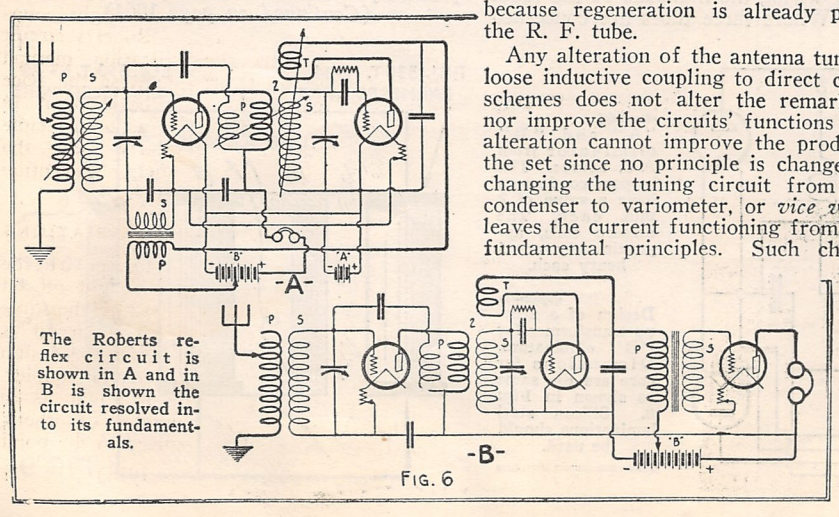
Any alteration of the antenna tuning from loose inductive coupling to direct connection schemes does not alter the remarks above, nor improve the circuits' functions any. The alteration cannot improve the production of the set since no principle is changed. Also, changing the tuning circuit from coil and condenser to variometer, or *vice versa*, still leaves the current functioning from the same fundamental principles. Such changes as these last-named sorts are detail changes. Assuming proper and careful design in both cases, the sole difference will be the mechanical one of an alteration of the tuning "feel." No electric change is apparent, or, in simpler words, the set does not become capable of more DX. Changes that mean no more than an alteration of rheostat, inductance or condenser type, assuming a similarity of electric performance in the alternate, mean no more change than the change which would be effected in an auto which has a new wheel substituted for the old one in use, or its carbureter replaced. If there is no difference in the quality of the units, the car's performance remains unchanged.

The replacement of variometer variation for regeneration control by the tickler method has no essential effect on the circuit's performance. It increases neither sensitivity nor volume. From an immediate practical viewpoint, then, the two methods are equal. Therefore, as we consider only the electric conditions of the circuits for the nonce, detector regeneration, when mentioned, includes any system that results in a controllably oscillatory detector circuit. And, if controllable, all regenerative detector arrangements are equally sensitive.

THE NEUTRODYNE

Our next step in the growth of the crude single-circuit devices of radio broadcasting's first popular stages was the fortunate arrival of the neutrodyne. The main misfortune from which the various neutrodyne sets have had to suffer has been poor engineering. However, today we have good and better neutrodynes, with promise of more improvement in the future.

Again the hack writer, this prolific producer of good and bad ideas, saw logically toward the next step: the use of the regenerative detector with the neutrodyned R. F.

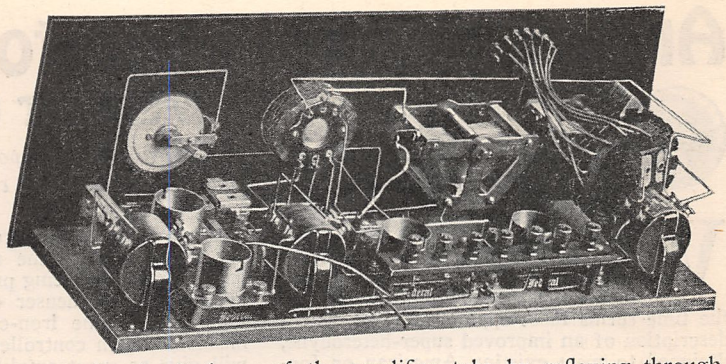


The Roberts reflex circuit is shown in A and in B is shown the circuit resolved into its fundamentals.

FIG. 6

amplifiers. However, in the main, the neutrodyne sets consisted of two stages of tuned R. F. amplification. With two stages of even partially effective tuned R. F. amplification, regeneration in the detector usually means too little gain to be of practical value. If the R. F. amplification is really effective in both stages, the added regeneration control of the detector circuit will mean nothing save added complication. But, if one drops back to the well-known one-R.-F.-plus-detector, with the detector regenerative, a tube is saved at no apparent loss in amplification, since the regenerative detector begins to be a useful amplifier.

Now there exist many more circuits using the basic circuit of Fig. 1, but each with a special name. A discussion of a few will lead to an interesting understanding and better viewpoint on others of similar origin. Those immediately thought of are the once-famous Teledyne, the Craig, the Browning-Drake, the Roberts, the Harkness Counterflex, when arranged with a regenerative detector, and a simple unknown which has been perpetrated by so many authors that I am taking one of my own variations of it to dissect, as some of the remarks I desire to make might incite indignation in others. This last was "designed" for publication in a newspaper radio section and it was offered as the thing it was, one stage of non-oscillating R. F. amplification plus the regenerative detector. There was audio-amplification and detail arrangement due to the writer's conception as to how the set should be built for whom and what it was intended.



The Roberts receiver with a stage of push-pull amplification. On the right is a tapped antenna coil. The R.F. transformer is on the panel at the left.

THE TELEDYNE

The Teledyne is illustrated in Fig. 5. It is dug from out the limbo of forgotten things and dusted off for popular view that it might be compared with some of the more modern posterity. It differs but little from the basic circuit, which I venture will be a surprise to some. The elimination of oscillation in the R. F. tube is accomplished mainly by reducing the primary turns (2) sufficiently. The circuit needs no discussion.

The Craig is mentioned for no other purpose than to help by showing how silly it is to attach a man's name to a normal circuit. The article, as written, made no attempt to be other than it was—a complete and clear constructional article. The circuit was one stage of neutralized R. F. amplification, regenerative detector and two stages of audio amplification. Neutralization of the R. F. amplifier was simplified apparently by a reduction in the number of primary (2) turns below the quantity possible. What attaching of Craig's name to the circuit that there was due to the average radio reader's painful habit of so doing. The pages of radio publications have been littered with similar circuits. The reader would simplify matters greatly if he would pay more attention to the simpler electrical divisions of a circuit than to the writer's name.

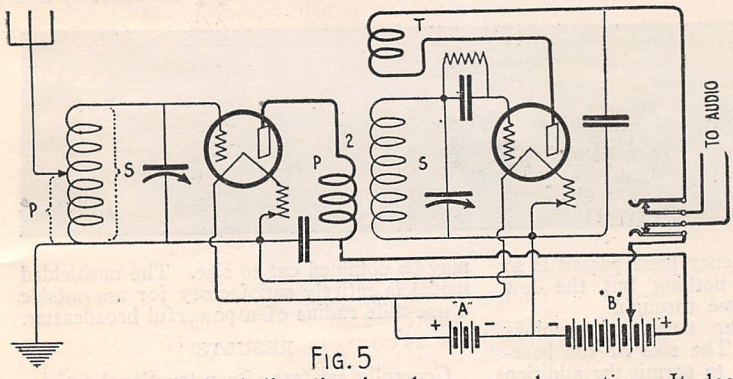


FIG. 5

This is the Teledyne circuit. The oscillations in the radio frequency amplifier are cut down by reducing the number of turns in the primary of the R.F. transformer.

AN EXCELLENT VARIATION

The Roberts circuit, Fig. 6, will seem, at a cursory glance not to fit in with this conglomeration. It does, however, as soon as it is resolved from a reflex to a straight circuit, showing schematically all things performed in Fig. 6A, 6B, then, shows the one stage of R. F. amplification, neutralized, regenerative detector and stage of audio-amplification necessarily produced through the reflexing in A. The circuit deserves high commendation. It tunes the antenna circuit roughly but that is enough, fairly loosely couples it to the amplifier tube circuits, which is an appreciable selectivity gain, provides a non-oscillating R. F. amplifier, provides a regenerative detector for complete use of the detector tube in gaining volume and sensitivity, provides full use of the amplifier tube by reflexing through it a stage of audio-amplification and provides, finally, a variable inductive coupling between the R. F. tube output and the detector input. This last touch is the "master touch on a masterpiece." The circuit is completely and carefully designed with practically no detail uncared for to be discovered later as a disadvantage; in the writer's opinion the set would be ideal if it did not reflex. He confesses an entire lack of faith in reflexing in general but *not* in one-tube reflexes particularly. In fact, a single-tube reflex is the best type of reflex available, anyhow—and the only type that seems to come near to producing what might be expected. This is one of the most completely effective circuits it has been the writer's pleasure to handle or see used. One thing must be mentioned: spider-web coils are not a "must" of the circuit; but any kind of coils used, provided the advantages mentioned are kept, will give similar results.

Please let me paragraph the things done in the circuit. It has a maximum of senitivity, volume and selectivity with simple control and no radiation—peace for yourself and the neighbor. Electrically and mechanically a good circuit.

Similarly the Harkness reflex (Counterflex, Fig. 7) fits in with this when it is shown with the regenerative detector, as it sometimes is. Its advantages, since it is directly similar to the previous circuit, are somewhat curtailed by direct antenna connection, sacrifice of R. F. amplification through the reduction of the number of the primary (2) circuit turns and tight coupling throughout. Where the Roberts circuit uses the Hazeltine neutralization method (neutrodyne), the Harkness usese the Rice method. This is the only basic point in which the two circuits differ as to principle and even these result similarly, since the function is the same; namely, prevention of oscillation in the R. F. tube.

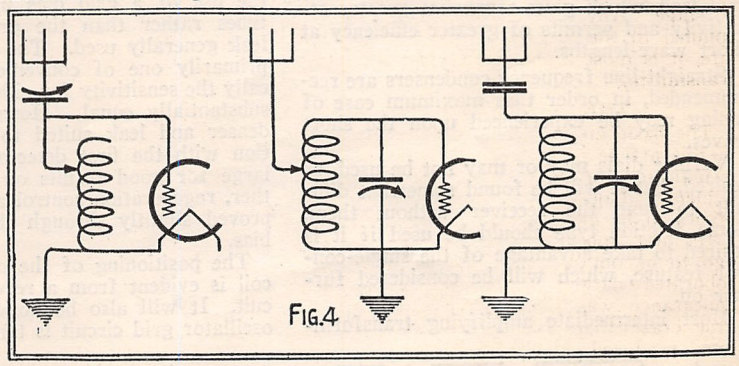


FIG. 4

Three types of conductive coupling are shown at the right. None of these systems can compare with the inductive type of coupling due to the selectivity of the latter type.

THE BEST OF THE MODERN VARIATIONS

We come now to the top-liner of the bunch, the Browning-Drake. Right off let me say that the circuit is basically the same old one shown in Fig. 1. The circuit is shown in Fig. 8. The gain lies in the design of the primary (2) of the detector coupler. General design was cutting it down, as in the case to follow and a number of others, since the turns could be reduced to the point

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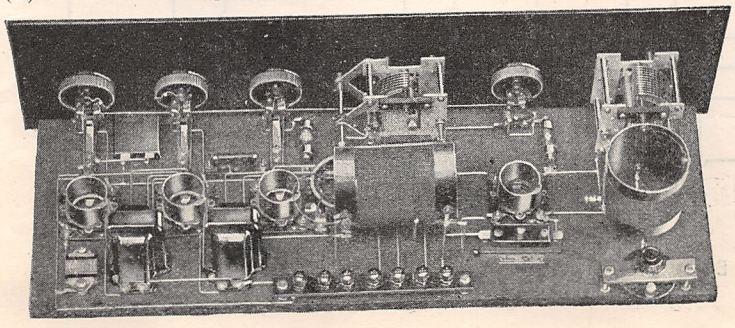


On the left is shown the Teledyne receiver, the circuit of which is shown in Fig. 5 above, to which is added two stages of audio frequency amplification. Notice that the inductances are at right angles in order to prevent any inductive effects.

An Improved Laboratory Super-Heterodyne

By ERNEST R. PFAFF

Here is another super-heterodyne, which incorporates two rather novel ideas. One is the use of plug-in inductance and the other is the connection of the oscillator first detector.

WITH the advent of a new radio season, bringing with it receiving conditions differing immeasurably from those encountered last year, the time seems most opportune to present a description of an improved super-heterodyne, designed to meet existing American or foreign broadcast conditions.

Aside from the increased number of broadcasters, and their increased power, there is the extension of wave-length ranges to be considered. Last year 250 meters was the low limit in practical use. Today it is 300,000 cycles higher, or 200 meters. Few of last year's receivers will efficiently reach this new low limit. Rebroadcasting brings in an even lower limit, so that our really practical receiver must go down to 50 meters and up to 550. If it is desired to listen to the high-powered European stations, then this range must be extended to 2700 meters.

SPECIFICATIONS

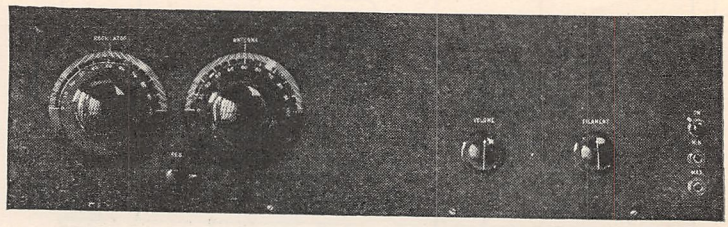
Possibly the first features to strike the eye are the interchangeable oscillator and antenna coil systems. Plug-in coils are used in each circuit, arranged to cover the desired wave-length range. Three coils are used in either oscillator or antenna circuit to tune from 50 to 550 meters. They are wound upon moulded bakelite forms.

If a loop is to be used, it is merely necessary to remove the antenna coil from its six-contact socket and connect the loop to three binding posts on the socket. For different wave-length ranges, both oscillator and antenna coils are merely plugged in or out, exactly as a tube would be. The oscillator coupling coil is connected in the filament return of the first detector rather than in the grid lead, which gives somewhat greater selectivity and permits of greater efficiency at short wave-lengths.

Straight-line frequency condensers are recommended, in order that maximum ease of tuning may be experienced upon the short waves.

Vernier dials may or may not be used, as desired, but it will be found somewhat difficult to tune the receiver without them. Some friction type should be used if it is desired to take advantage of the single-control feature, which will be considered further on.

Most intermediate amplifying transformers and filters are carefully tuned at the factory to exactly the same operating frequency, the filter being provided with a measured tuning condenser of exactly the correct value. The iron-core type is recommended. With controlled regeneration these will give as great amplification as it is possible to obtain. The over-all amplification curve of the two-stage amplifier is very similar to that of an extremely good band-pass filter as used in carrier telephone work. This means that a band only wide enough to pass the desired signal receives amplification. In this particular amplifier, the width of the band may be varied by the volume control, from a width so great that selectivity and amplification are poor, up through a good operating condition, and on to a point where the frequency band passed is so narrow that little or nothing but the low notes of a station come through.



A front panel view of the new improved super-heterodyne. Note the simplicity of controls.

The audio amplifier suggested employs 3½:1 transformers. The size of the baseboard is great enough to permit the addition of an extra tube, so that a three-stage resistance coupled amplifier might be used, or a three-stage choke coupled amplifier, to be selected by the individual builder.

The circuit is not at all new, except for the use of a grid bias upon both detector tubes rather than the grid condenser and leak generally used. The reason for this is primarily one of convenience, since practically the sensitivity for either system appears substantially equal. However, a grid condenser and leak suited to broadcast reception with the first detector would be too large for good results on low waves. Further, regeneration control and selectivity improved slightly through the use of a grid bias.

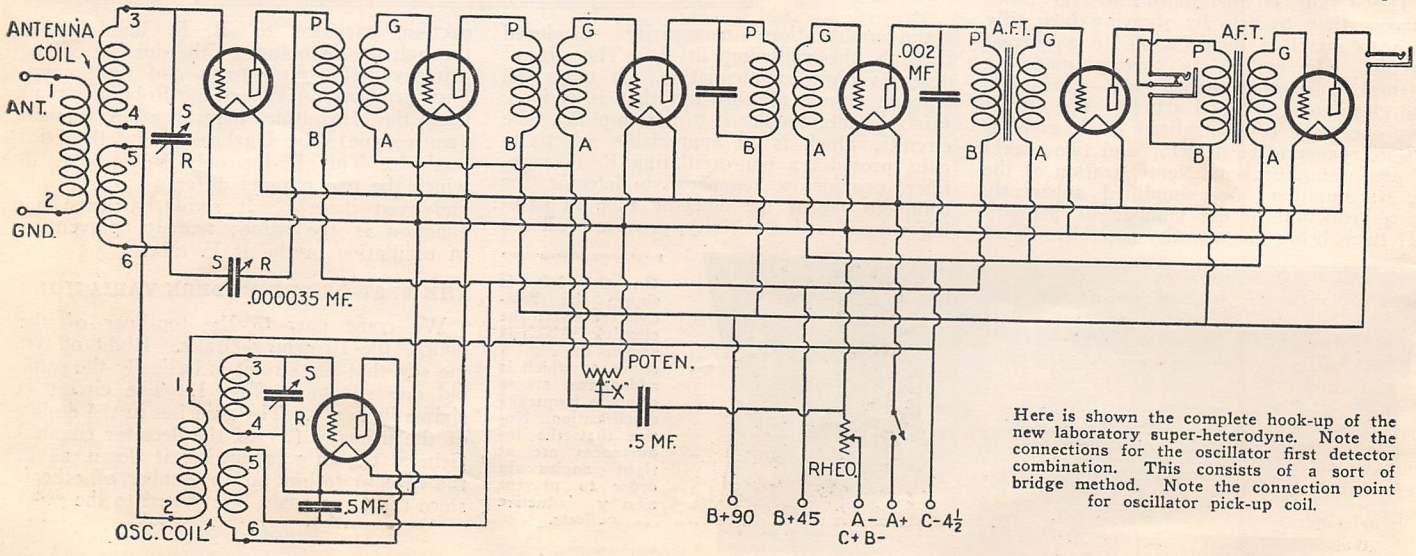
The positioning of the oscillator coupling coil is evident from a reference to the circuit. It will also be noticed that only the oscillator grid circuit is tuned, thus bringing one side of the oscillator tuning condenser at ground potential, and eliminating any tendency toward hand capacity effect.

The mechanical features of the set are quite simple. Photos are shown of the shielded model. An aluminum sub-base, together with an aluminum panel shield is used. If the back, ends, and top of the cabinet in which the set is placed are also shielded, the selectivity obtainable will be remarkable. The choice between the shielded and unshielded methods of construction is quite simple. If the receiver is less than a mile from a broadcaster, then the shielded model should be selected, by all means. Though its assembly may appear a task for a tinsmith, it is really quite simple, since the aluminum works as easily as bakelite, and may be obtained cut to size. The unshielded model is entirely satisfactory for use outside a one-mile radius of a powerful broadcaster.

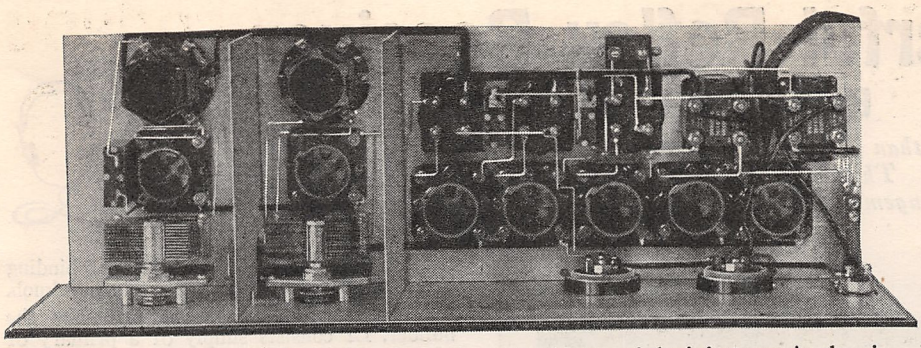
RESULTS

Generally, writers of constructional articles feel that their work is incomplete without a glowing tale of the wonderful results obtained from their particular circuit. The writer is no exception, nor is it assumed that the reader would wish to remain uninformed of what may be expected from the sets. During August a test was run in a building adjacent to a new steel frame hotel in the Chicago loop district. Some twenty out-of-town stations were logged between nine and twelve o'clock including coast stations. More were heard, but could not be logged, due to terrific static and elevated railway interference—located less than 75 feet away. However, the important fact is that within a radius of but a few miles, some ten local stations were operating—three of them not half a mile distant. Yet the selectivity was such that no trouble was experienced in working.

Parts for this set should be selected which will co-ordinate properly, and are of equal



Here is shown the complete hook-up of the new laboratory super-heterodyne. Note the connections for the oscillator first detector combination. This consists of a sort of bridge method. Note the connection point for oscillator pick-up coil.



This view of the new super-heterodyne shows the parts with two of the inductances in place in the receptacles. It also shows the building.

quality, since the results obtainable are dependent, in a large measure, upon the use of the parts selected.

A list of material is given in the accompanying box.

2	.00035 SLF condensers.
2	4" moulded dials, vernier preferably.
1	6-ohm rheostat.
1	200- to 400-ohm potentiometer.
1	2-Spring jack.
1	1-Spring jack.
2	Charted intermediate transformers.
1	Tuned filter with condenser.
7	Spring sockets, UX or UV.
2	3½:1 audio transformers.
1	On-off switch.
3	.5 mf. bypass condensers.
1	.002 bypass condenser.
1	.000025 mf. balancing condenser.
1	7x24x⅛" bakelite panel.
1	7½x23 oak or aluminum sub-base.
2	Coil sockets, screws, lugs, nuts, solder, spaghetti, etc.

If the completely shielded model is to be built, additional aluminum shielding will be required. The sub-base should be No. 8 gauge, while the balance may be No. 20 gauge, cut to fit the desired cabinet.

No specifications for the oscillator coils have been given. It is possible to use standard six-contact forms for these coils, which can be procured on the market, as these will plug into the sockets listed very nicely and are completely provided with hardware. They may be procured wound or unwound, as desired. The winding specifications are given below.

For the antenna coil, the stator tube should be wound with two equal sections, and the rotor tube with one section split for the rotor bearings as listed:

190—550 meters:
Stator ..... 43 turns per coil
Rotor ..... 40 turns per coil

90—210 meters:
Stator ..... 16 turns per coil
Rotor ..... 10 turns per coil

50—110 meters:
Stator ..... 7 turns per coil
Rotor ..... 6 turns per coil

For the oscillator system, the top stator coil is much larger than the bottom one, the larger being used in the grid circuit, the smaller in the plate circuit. For the rotor and pick-up coil, the winding specifications are as follows:

190—550 meters:
Large stator ..... 84 turns
Small stator ..... 25 turns
Rotor ..... 40 turns

90—210 meters:
Large stator ..... 32 turns
Small stator ..... 14 turns
Rotor ..... 10 turns

50—110 meters:
Large stator ..... 14 turns
Small stator ..... 10 turns
Rotor ..... 6 turns

In all cases, the stators are wound as one continuous winding, the top end being No. 3, the bottom end of this winding being No. 4, the top end of the next winding being No. 5, and the bottom end of this winding being No. 6. The rotor numbers are 1 and 2. These coils may be clipped in at will and adjusted to any desired position. After being once set, they need never be disturbed.

Any standard type of tube may be employed. The writer prefers UX-199 tubes up to the second audio stage, with UX-120 for the last stage. UX-201As, with the last stage UX-112, will give slightly greater handling capacity, higher "B" battery consumption and, possibly, a little more volume.

CONSTRUCTION

Should the aluminum shield be used, holes must be drilled in it to correspond with those in the panel, but so over-sized that no instrument will short on it, except the oscillator condenser, the frame of which goes to the negative filament line, which is also the shield.

If the sub-base is of wood, wood-screws will serve to fasten all parts to it, and it, in turn, to the panel. If an aluminum sub-base is used, machine screws (6/32) and nuts will be required.

The wiring is quite simple, requiring only the usual bus-bar, spaghetti, well-tinned soldering iron, non-corrosive paste and resin-core solder. No battery binding posts are provided, the short ends of the color cable being terminated directly at instrument binding posts, while the long ends go directly to the batteries.

The preliminary testing of the set is quite simple. It should first have only the "A" battery connected to it, and the tubes inserted in their sockets. They should, of course, light, and have their brilliancy controlled by the rheostat. The negative "A" battery lead should be left connected and the plus lead removed and touched first to the "B" 45 and then to the "B" 90 leads. The tubes should not light with either of these connections. If they do, an error has been made in wiring and must be corrected before proceeding further.

The tubes being in their sockets, the rheostat should be turned about seven-eighths on for storage battery tubes. The proper adjustment for UX-199 tubes (dry cell) may be arrived at by the use of a filament voltmeter, which is vitally important for use with this type of tube.

Two of the larger size oscillator coils and antenna coils should be put in their respective sockets, and the balancing condenser turned all out. Then, if the potentiometer is turned from its positive to its negative side, a "plunk" will be heard, followed by squeals if the oscillator dial is rotated. The potentiometer should be turned back far enough so that no squeals will be heard, in which position it should be left unless it is desired to vary the signal volume with it.

If the oscillator and antenna dials are rotated slowly, varying the oscillator through a range of 10 degrees above to 10 degrees below the antenna setting for each 2-degree step with the antenna dial, signals will be heard if any local stations are operating. An antenna not over 40 to 60 feet long, indoor or outdoor, and a ground, may be connected to terminals 1 and 2 of the antenna coil socket, or one just behind the antenna condenser and first detector tube. Selectivity may be regulated by adjusting the position of the rotor coil with the fingers. Once set, it need not be disturbed. This is true for all sizes of antenna coils, for the different wave-length bands.

The oscillator coupling is not generally critical and the oscillator rotor should have its axis coinciding with that of the stator tube to start with. Selectivity may be improved by turning it slowly out. It will be found, however, that turning it a full 180 degrees around may increase signal strength on weak stations. In some extreme cases it may even be necessary to connect it in the first detector grid lead rather than in the filament return. This should be tried at once, should the receiver fail to operate properly.

In first tuning the set few signals will be heard, due to the extreme selectivity. Therefore, it may be well to do away with the regenerative first detector circuit temporarily by reconnecting the circuit as suggested in the circuit diagram. This will render the antenna tuning quite broad, with consequent ease of handling, but at the expense not only of selectivity, but of a considerable degree of sensitivity.

SINGLE CONTROL

Using the non-regenerative first detector connection, the antenna tuning will be broad enough so that if the two tuning condensers are geared together, one knob may be used for tuning, thus simplifying control. This is as practical an arrangement as can be used in any super. The antenna tuning being broad, it is possible to vary both condensers at once, keeping them a uniform number of degrees apart, and yet still obtain the best setting for all waves on both condensers.

In view of the single-control feature, the use of a loop has not been seriously considered. However, it may be used with per-

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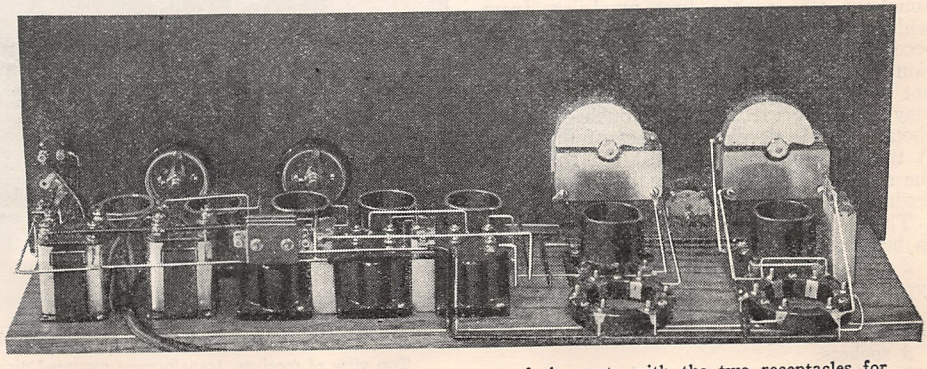
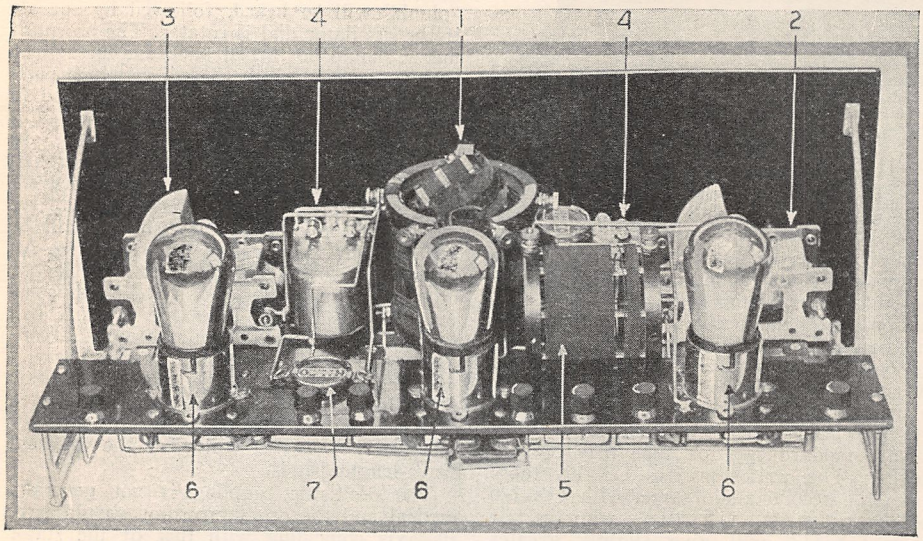


This view of the new super shows the arrangement of the parts with the two receptacles for taking the inductances. The model picture is the unshielded type.

A Powerful Reflex Receiver

By ARTHUR REED

In the reflex receiver, more than in most other types, successful operation is dependent upon good arrangement of parts. This article presents nothing new in theory, but gives the most efficient arrangement of parts that has come to our attention.



A direct view of the rear of the reflex receiver showing the position of the parts. Notice how simple the neat layout is made by the three gang sockets and brackets.

THIS receiver was designed after some deliberation concerning the prime factors of an efficient, economic receiver; a stage of radio frequency to build up the signal strength of distant or low power stations, a tube detector with regeneration to increase the set's sensitivity, and volume; and two stages of audio frequency amplification for good loud speaker reception. However, the writer did not wish to employ more than three tubes, and so the circuit diagram illustrated in Fig. 1 was adopted. The first tube is the reflex tube, being both the radio and audio frequency amplifier; the second tube the detector with the tickler method of obtaining regeneration, the third and last tube the second audio amplifier.

THE THEORY OF THE CIRCUIT

The theory of the receiver may be explained as follows: The incoming signals are impressed upon the grid of the first tube after the condenser C3 has tuned the radio frequency circuit into resonance with the frequency of the signal, and amplified at radio frequencies, then the amplified signal (still at radio frequencies) is impressed upon the grid of the second tube, after the detector circuit, controlled by C4, is brought into resonance with the frequency of the signal. The second tube, being a detector tube, rectifies the signal which is re-enforced by regeneration, and then the signal is sent back and impressed upon the first tube, which functions also as the first amplifier, from which it is then sent to the third tube, or second audio amplifier. The above explanation of the action of the receiver, although not essential to the building of the receiver, may be a great aid in trouble-shooting, should trouble develop in a set of this type. A thorough understanding of the course of the signal will be a considerable aid in diagnosing the trouble.

The following is a list of parts necessary to build this outfit:

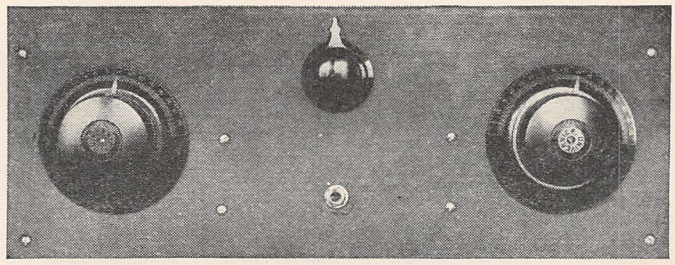
2 .0005 mfd. variable condensers—low loss type.

2 audio frequency transformers, either 6-1, and 3½-1, or both low ratio.

3 sockets.

1 inductance, consisting of primary and secondary windings, the latter designed for use with .0005 mfd. condenser.

1 three-circuit tuner, consisting of primary, secondary, and tickler windings, the secondary designed for use with .0005 mfd. condenser.



Front view of receiver. Simplicity and ease of operation is the keynote. Center knob controls volume.

1 7 x 18 bakelite panel.

1 7 x 18 cabinet.

1 filament control jack, single open circuit type.

1 grid condenser .00025 mfd.

1 two-megohm grid leak.

3 fixed condensers, .0005 mfd., .0001 mfd., and .0001 mfd., again.

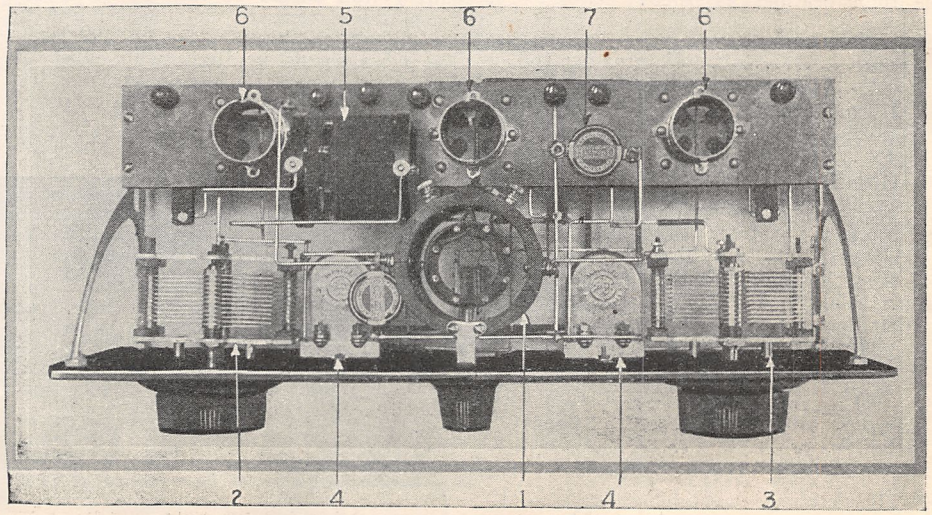
Miscellaneous—such as brackets, binding posts, wood-screws, two dials and one knob.

Both inductances may be made by the builder. L1 consists simply of a primary of 10 turns No. 22 D.S.C., and secondary of 46 turns of the same size wire, both windings wound on a 4-inch bakelite tube, three inches in diameter, and 3/8 inch apart (illustrated in Fig. 2). The variocoupler consists of a 10-turn primary, 46-turn secondary and a 30-turn rotor, all wound with No. 22 D.S.C. (See Fig. 3.)

CHOICE OF PARTS AND LAYOUT

For the parts, only reliable and standard merchandise should be purchased. It is essential to the efficiency of the receiver that only well-designed apparatus be used. The cost of all the parts for this receiver, including cabinet, should not exceed twenty dollars, dependent, of course, upon the economy of the purchaser and the foresight he uses. With tubes, batteries, loud speaker and antenna equipment the total cost of the set should approximate fifty dollars.

In laying out the parts, a baseboard 17 inches long by 7 inches deep and ½ inch thick may be substituted. The plain inductance coil should be placed near the first tube, the variocoupler near the second tube, the first audio frequency transformer near the first tube and the second audio frequency transformer near the third tube. All this will help to shorten the leads from the coil to grid and plate of the tubes. A filament control jack is used in the set shown but a switch may be used in conjunction with an ordinary single circuit jack. Should the builder desire a three-gang socket with brackets, a layout similar to the one shown in the photograph may be used.



Top view of receiver, transformers mounted directly on panel. The coils are placed at right angles to each other.

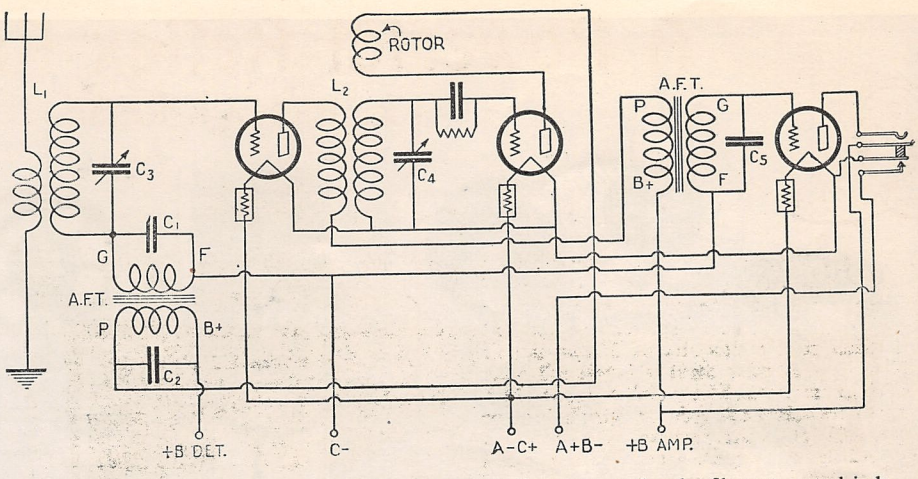
The adjustment of the receiver after it is given its first trial test may be somewhat critical. A few words on the subject will enlighten the builder considerably. The set should oscillate, or whistle, as the ordinary layman terms it. Should it fail to do so, reversing the tickler coil leads, or increasing the detector "B" voltage, or placing a larger by-pass condenser across the primary will help, unless the set is incorrectly wired. Incidentally, in first testing a set, place only a single tube in the tube socket or a 40-watt lamp in series with the "B" lead to prevent tube burnouts in case of short circuits or misplaced wires. In case of violent oscillations, a reduction in the number of turns in the tickler coil, or lower detector voltage is the remedy.

In building the set it is essential that a well-planned wiring and soldering job be done, which will, of course, increase the sensitivity and distance range of the set. With this set the writer has logged 32 stations in two evenings, being able at will to tune out any of the eighteen local stations in New York City, and secure a distant station with good volume in the loud speaker. Among the distant stations received were: WOO, Philadelphia; WLW, Cincinnati; KDKA, Pittsburgh; CNRO, Canada; WBZ, Springfield; WMBF, Miami; and WGN, Chicago.

HINTS FOR THE BUILDER

A few additional suggestions to the builder of this set: The capacities of the fixed condensers mentioned in this set, though somewhat critical, should not vary greatly from the stated capacities unless the wiring of the set is very crowded and a faint continuous whistle is heard along with the reception of the stations. In tuning the set, the stations may be logged for later reference, the dial readings being the same from one day, week or month, to the next. The dial readings will bear a close relation to each other; if one is 40, the other will be very close to 40, perhaps 38 or 42, or even 40, depending upon the size of the antenna, which affects the left dial reading. The center knob or tickler coil is used to control the sensitivity and volume of the set. The receiver as shown was primarily designed for use with the six-volt type tubes, but may be used with either UV or Cunningham 199 tubes with good results, but with some decrease in volume as compared to the larger tubes.

The writer is positive that builders of this set will be more than satisfied with the "pep" and sensitivity obtained should the above instructions be carefully followed.

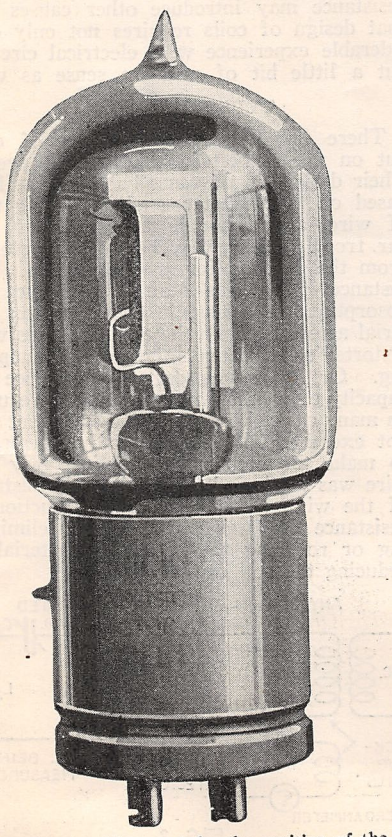


Schematic diagram of the receiver. Automatic current filament control and a filament control jack are two features that aid in simplicity of tuning.

A Non-Microphonic Vacuum Tube

By HERNDON GREEN

One of the most annoying forms of extraneous noise in a radio receiver is the hum set up by mechanical vibration of the elements of the tube, whenever it receives a mechanical shock. This new tube is designed to do away with all such microphonic noises.



Note that in this new tube the position of the elements is horizontal, at an angle of 90° from the usual method of mounting.

WITHIN the last few months there have appeared on the market several new types of vacuum tubes.

One of the tubes that recently was presented to the radio public is shown in the accompanying photographs. Nothing startling is claimed by the manufacturer for this vacuum tube, except that it is non-microphonic. The characteristics are about the same as other standard types made by the same firms, but the internal construction is much improved.

The elements are so arranged that there is no possibility of their touching each other, thereby causing a short circuit and ruining the tube. The leads are so placed that there is no danger of short circuits from this source either. Then, in order to make the tube non-microphonic, the three elements are so fixed in position that they cannot vibrate separately.

These innovations may easily be seen upon inspection of the photograph of the elements of the tube. Inside each end of the plate, which is firmly attached to the glass stem by heavy wire, there is a thin strip of lava insulation, marked by Fig. 1 in the photograph. Between these two pieces of insulation are suspended the filament and grid, shown at 4 and 5 respectively in the photograph. It will be seen that with a construction of this nature it is almost an impossibility for any of the three elements to touch.

The glass tube shown at 2 in the photograph is embedded at its lower end in the glass stem of the vacuum tube and through it is run the lead to the plate. On the other

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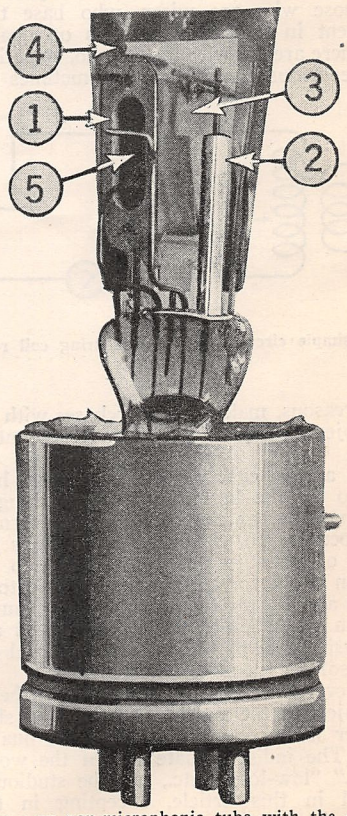
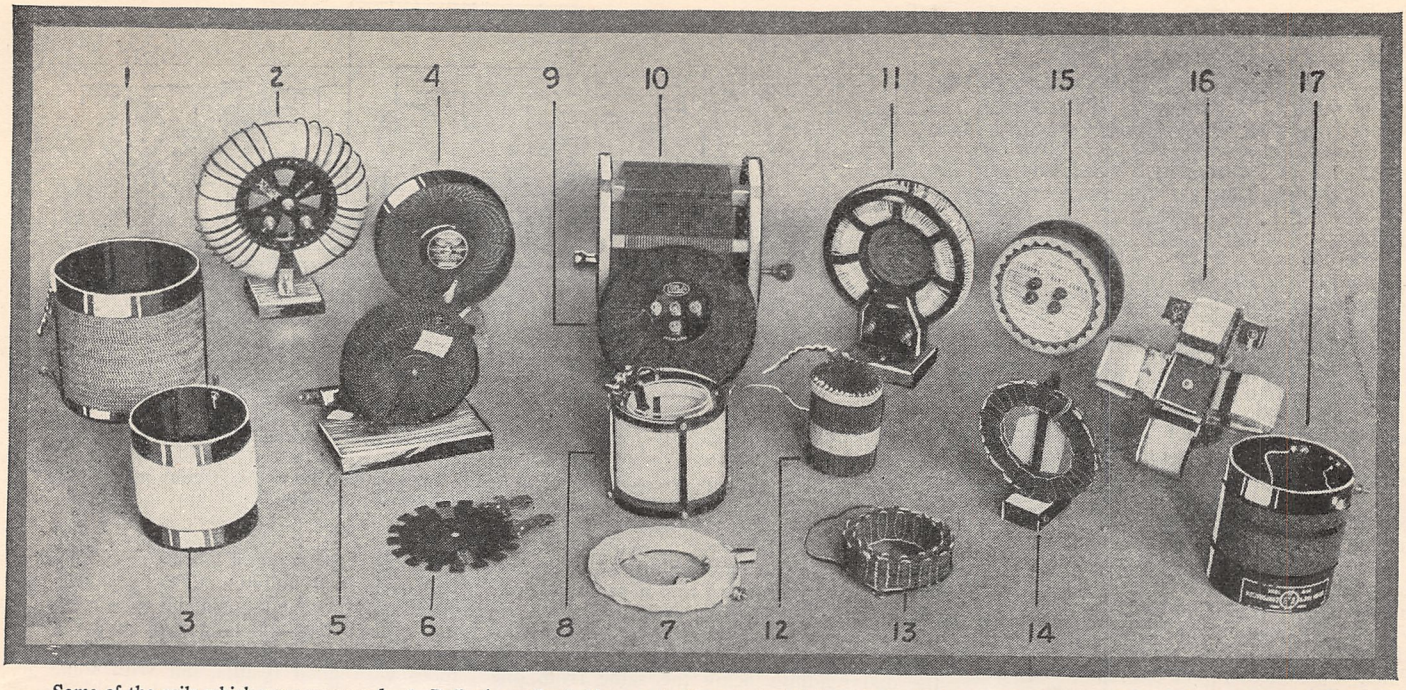


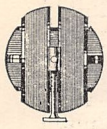
The new non-microphonic tube with the glass envelope removed to show the manner of mounting the elements to prevent any one from vibrating separately.



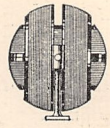
Some of the coils which were measured. 1, Bell wire coil; 2, Naxon; 3, Marco; 4, All-American; 5, Orbit; 6, Turney; 7, Sickles; 8, Aerocoil; 9, Erla; 10, Wavemeter coil; 11, Thorola; 12, Pathe; 13, Freshman; 14, Coast Coil; 15, Summitt; 16, Quadroformer; 17, Bruno.

Which Type Of Coil Is Best?

By the Laboratory Staff of RADIO NEWS



Despite many claims to the contrary, all coils are not best coils. An extensive study of commercial makes of various coils was made in RADIO NEWS *Laboratory and is here presented.*



IT IS an old, old story that when a thing is to be bought, the old, old controversy between quality, quantity and cost arises. There are those whose purchases are made mainly on the basis of quantity. There are those who are wiser, who base their judgment in making purchases on quality. And there are likewise those, who, sometimes for penurious reasons, and sometimes for other reasons, make their purchases with the sole object of spending the least amount of money.

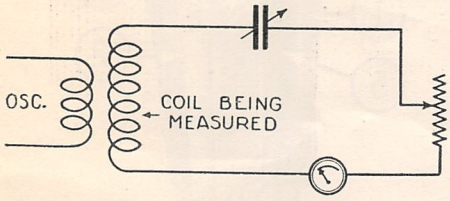


FIG. 1

The simple circuit used in measuring coil resistance.

It is a rare case when the cheapest happens to be the best; but such a thing is quite possible, as my readers will learn as we proceed. In connection with coils the matter of quantity does not enter into the question at all, for the number of coils to be used in a radio receiver is a definite quantity (pardon the indefinite use of the word) and the physical size of the coil is immaterial except insofar as it affects its quality.

However, without philosophizing further—the subject of the article is "coils"—we shall consider now coils with respect to quality only. The indiscriminate use of the words "losses," "low-loss," etc., will be studiously avoided in this article, excepting in this paragraph, for the writer, as well as many others, is aware of the many misconceptions that have arisen in this respect because of the looseness of the English language. It is well to be definite even if this does require an additional amount of breath to enunciate a qualifying adjective, such as "power" loss, "energy" loss, etc. Such losses, (qualified in the preceding sentence), in electrical circuits, such as exist in radio receivers where the condition of resonance is generally obtained, are a direct function of the resistance of the circuits, so that hereafter we shall speak not of the losses, whatever their qualifying adjectives may be, but of the resistance of coils.

THE problem of what type of coil to use in a radio receiver is a vital one, and its satisfactory solution frequently determines whether or not the operation of the receiver will be satisfactory.

In this article, the subject is discussed from the point of view of resistance of the coils only. There are other points on which the proper choice of a coil depends, but this is perhaps the most important one, as it determines to a great extent the efficiency of the receiver.

Nothing has been published, so far as we know, on the exact electrical properties of some of the coils included in this study, notably those of the toroidal form.

What we desire in coils is inductance, and nothing else. Things other than inductance are present in coils, however, which are not desirable, for many reasons. Among these things are self capacity (often called distributed capacity), the natural D.C. or ohmic resistance of the wire, skin-effect in the wire due to the effects of frequency, and leakage and absorption in or through the insulating materials upon which the coil is built or with which the wire is covered. All these items contribute to the resistance of coils, so it becomes well to know which are the more important in determining the resistance. It will be seen later that attempts to eliminate one of these causes of resistance may introduce other causes and that design of coils requires not only considerable experience with electrical circuits, but a little bit of common sense as well.

TYPES OF COILS

There have been many forms of coils put on the market in the last few years. Their design, in all cases but one, has been based on the inductance of a circular turn of wire, and although many of them are far from circular, they have been distorted from the circular for special reasons. For instance, if it was desired to reduce the absorption or leakage in the insulation material associated with the coil, the turns were distorted so as to make the coil self-supporting. Or, if it was desired to reduce the capacity of the coil, other means were used. In many cases, however, good judgment was not exercised, for sometimes in attempting to make the coil self-supporting very fine wire was used, and the additional resistance of the wire far exceeded the reduction in resistance that was expected from eliminating or reducing the insulation material or reducing the coil capacity.

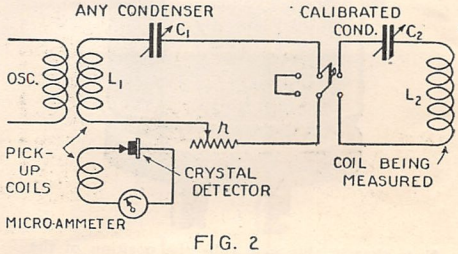
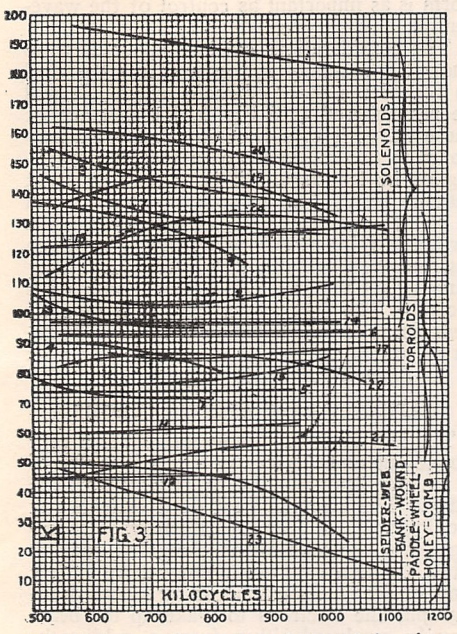


FIG. 2

Mr. Harris' improved circuit for measuring resistance of coils.

Since this article deals with the measured resistance of coils it will be well to describe the method used. But first the usual method will be described, and later the modification designed by Sylvan Harris, director of the Laboratory, which was necessary in order to conduct measurements on coils of the toroidal type. At the left of Fig. 1 is shown a generator of high frequency oscillations supplying energy to the measuring circuit which includes the coil to be measured, a variable condenser for tuning to resonance, a current-indicating device, and a non-inductive variable resistance. This latter resistor must be such that its resistance is accurately known at all frequencies. It must have the least amount of inductance and capacity possible, and for that reason in these measurements a short, straight piece of "Advance" wire, No. 30, was used, with which contact could be made at any point



The efficiency of a coil is indicated by the height of its curves on this graph.

by means of a slider. The wire was calibrated with regard to resistance by measurements made on a Wheatstone Bridge.

The coil to be measured is coupled to the oscillator and the resistance is cut out of the circuit completely, the only resistances then in the circuit being those of the coil, the meter and the condenser in series. The value of the current in the circuit is then read on the meter; then the resistance is inserted and adjusted to the value that causes the current to drop to one-half what it was before. It is evident, now, that since the voltage induced in the circuit is the same as before (the coupling or the oscillator adjustments not being changed) and since the current has been reduced to one-half its former value, that the resistance of the circuit must have been doubled. Therefore, the amount of resistance that was added is equal to the resistance of the total circuit. The resistance of the coil is then this value less the resistances of the condenser and meter. The resistance of the meter can be measured or is supplied by the manufacturer (thermocouple type) and offers no material difficulty. The greatest difficulty lies in determining the resistance of the condenser, the accurate measurement of which requires special methods. For this reason, the results shown in the curves of this article include the resistance of the condenser. For an accurate method of measuring condenser resistance see I.R.E. proceedings, February, 1925.

This method is satisfactory as regards ordinary cylindrical coils, or coils of the basket, disc, spider-web and Lorentz type, in fact, any type but the toroidal. The latter is so designed that it is difficult to couple it to outside circuits, so that even when coupled very closely to the oscillator, it is difficult to obtain sufficient current in the measuring circuit to make the measurements. Accordingly, the method described here, illustrated in Fig. 2, was used.

Very much greater accuracy can be obtained by this method than by the one previously described, for several reasons. In the first place, the manner in which resonance is indicated, that is, by the pick-up coil, crystal detector and microammeter, is much more sensitive than when, as in Fig. 1, a thermogalvanometer or current-squared meter is placed in the measuring circuit. Keeping the meter out of the circuit at the same time keeps the resistance of the circuit as low as possible, which makes the measurement of coil resistance more accurate.

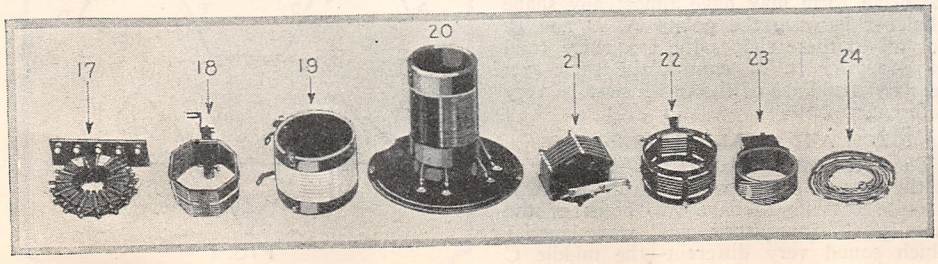
MEASURING THE COIL

The coil to be measured is placed in series with a pick-up coil, so that the electromotive force in the circuit is not developed in the coil under investigation, but in the pick-up coil. This makes it possible to make measurements on coils which have restricted magnetic fields, like the toroidal coils. The procedure is as follows:

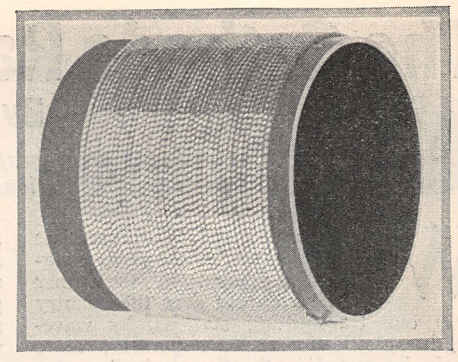
The switch is thrown to the left, the oscillator is adjusted to the desired wavelength or frequency, and the condenser C_1 is adjusted until the circuit is in resonance with the oscillator. The resistance r is set at zero. The circuit L_1C_1, therefore, when adjusted to resonance, has the properties of a pure resistance, consisting of the coil and condenser resistance in series. The switch is then thrown to the right, putting the two circuits in series, including the unknown coil L_2. Without touching the oscillator, L_1 or C_1, the calibrated condenser C_2 is then adjusted until resonance is again obtained.

With the two circuits thus in series and with r at zero, a certain indication is obtained in the microammeter. The switch is now thrown to the left, thereby cutting the resistance of L_2 and C_2 out of the circuit. The microammeter reading will increase, so to bring it back to what it was before, the resistance r is increased. The amount of resistance required in r is equal to the resistance of the coil L_2 and the condenser C_2 in series. This is evident from the fact that the emf. in the circuit has not been altered and the resistance of L_1 and C_1 are likewise unaltered.

It will be noted that the measurement is independent of the actual value of the current in the circuit, which is not true of the method illustrated in Fig. 1. As far as the current is concerned, all that interests us is



More of the coils which were measured. 17, Marwol; 18, Eastern Coil; 19, Workrite; 20, Walbert; 21, Andrews; 22, Bremer Tully; 23, Cotocoil; 24, Kresge Lorenz coil.

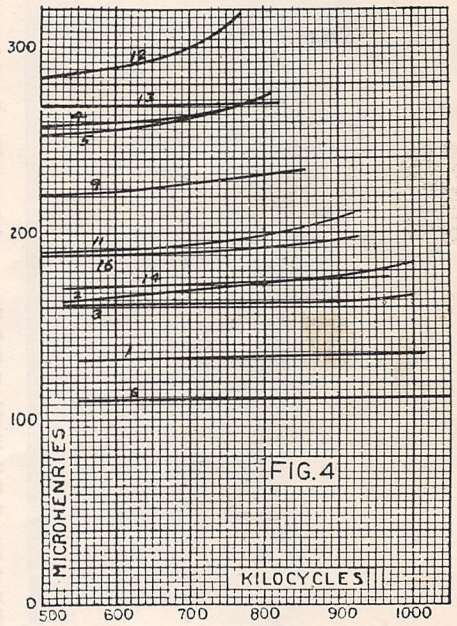


The cheapest and the best—a bell-wire coil.

to bring it back to the same value. It is also interesting to note that the adjustment of C_2 does not in any way affect the adjustment of C_1, for as stated before when C_1L_1 is adjusted to resonance, the pair act like a pure resistance in series with L_2 and C_2.

TESTING THE ACCURACY OF MEASUREMENT

The accuracy of the method was tested by connecting in place of L_2 or in series with it a known non-inductive resistance consisting of a short piece of Advance wire, No. 30. The resistance of the latter was measured by this method and then checked on a Wheatstone Bridge. It checked to 0.02 ohm. The resistance of the calibrated condenser was known to a like precision, and its resistance was in all cases deducted from the value obtained for L_2 and C_2 in series. Correction was also made for the resistance of the connecting wires to the right of the switch, the resistance of which was measured simply by taking L_2 and C_2 out of the circuit and bridging the gaps. The slight readjustment required in C_1 causes an unappreciable error. This was done at various frequencies. At the same time they were made as short as possible, thereby lessening the errors due to them.



The curvature of the graphs indicate the presence of distributed capacity in the coils.

In the laboratory, measurements are never made with the assumption that the measuring instruments are absolutely accurate. It is better to know the percentage of error and allow for it than to assume an accuracy that may or may not exist.

Before studying the results of the measurements, it will be well to investigate

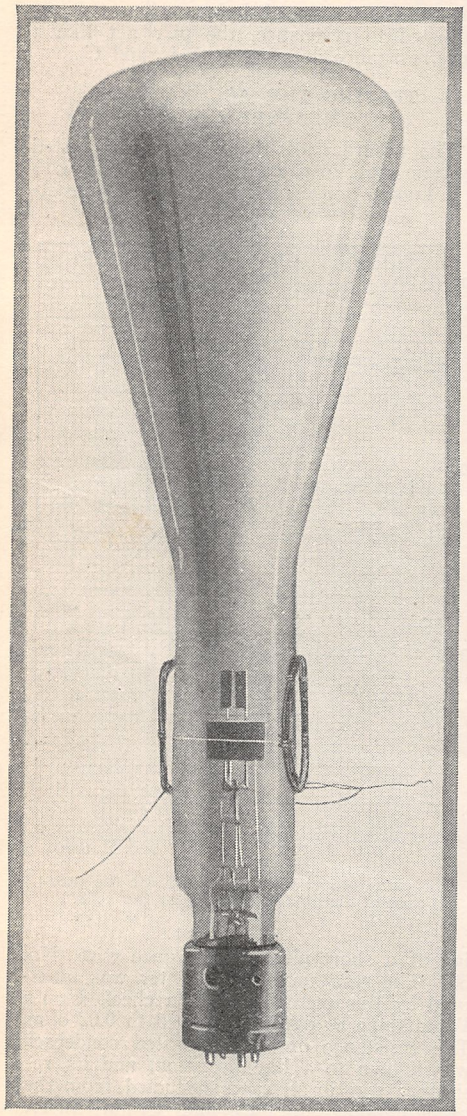
(*Continued on page* 1071)

The Cathode Ray Oscillograph In Radio Work

By DR. CHARLES B. BAZZONI*

The cathode-ray oscillograph is the only means we have for studying the wave-form of high frequency oscillations. Dr. Bazzoni explains the matter in very simple language.

WE are accustomed to differentiate "wireless waves," those electromagnetic disturbances in the ether which sweep out over the country from our transmitting stations, by wave-length specification. Some persons, more deeply interested in the "mysteries," prefer to base the differentiation on frequency—the frequency specifying the number of waves passing any given fixed point in a second. Since the speed of all these waves through



A commercial form of cathode oscillograph with coils attached for obtaining characteristic curves of vacuum tubes.

free space is the same, namely 186,000 miles per second, the wave-length can always be obtained, if the frequency is given, by dividing the distance covered in one second (186,000 miles equal to 300,000 cathometers) by the number of waves in that distance, *i. e.*, by the frequency. Two series of waves may show important differences in properties, due to differences in the *form* or *shape of the waves*. This feature of wireless waves, the *wave form*, is a difficult one to study and has for that reason been little investigated and less described.

REAL MEANING OF WAVE CURVE

Radio waves are generally represented by a wavy line, as at A, Fig. 1. What the line actually represents is the way in which the intensity of the electric force at any point passed over by the wave varies in strength, increasing or decreasing, as the wave passes. The magnetic intensity at the point also varies at the same time, which is why we call the wave an electromagnetic disturbance, but from the practical point of view the electrical intensity is the important feature. If we represent positive and negative values of the electric force up and down the vertical line at the left of B, Fig. 1, and time values along the horizontal line, then the variations in the electric force at a point passed over by a wave series of wave-length 500 meters (frequency 600,000 or, in other words, 600 kilocycles) can be read from the diagram. If at any instant the electric force at the point is zero then it will rise to a maximum positive value of 5 scale divisions, as drawn, in one two million four hundred thousandth of a second (1/2,400,000). It will fall to zero after one one million two hundred thousandths of a second, drop to a negative maximum of 5 divisions one two million four hundred thousandths of a second after crossing the zero value and come back to zero again after a total time of one six hundred thousandth of a second. These facts are deduced simply from a knowledge of the frequency which we can measure with accuracy. The only points on the curve which we actually know are A, D and B.

SINE WAVES

The assumption made in drawing the figure is that the successive values of the electric field at the point in question during its passage over its cycle follow the sine law—that is, that if the entire cycle from A to B is divided into 360 degrees (C, Fig. 1), measured along the horizontal line, then the electric force at any instant is taken to be proportional to the sine of the corresponding angle. For instance, the value of the force at A is equal to its value at M multiplied by the sine of 40° (0.643), and so on for other points a, c, d, e. Now this is a natural assumption to make and, no doubt, in many cases substantially represents the facts. Nevertheless, there are important exceptional cases where the variation of the electric force through the cycle does not follow the sine law. As examples the variation may be as shown at D or at E, Fig. 1. At D we have the nature of the variation, the "wave form," resulting when for some reason the source of the disturbance, the transmitting tube, for example, has been limited in some way so that its maximum output is below its natural value. At E the wave form is not "pure," it is not of a single frequency, but is complicated by multiple frequencies two, three or four times as rapid as the main one, but much less in intensity, such as very often occur in resonant circuits attached to oscillating vacuum tubes. Many other examples might be given for, as a matter of fact, the line representing the wave form may have almost any shape whatever between the points A, D and B. For all of these shapes the frequency (and wave-length) is, of course, the same—yet the nature and use of the waves may be very different.

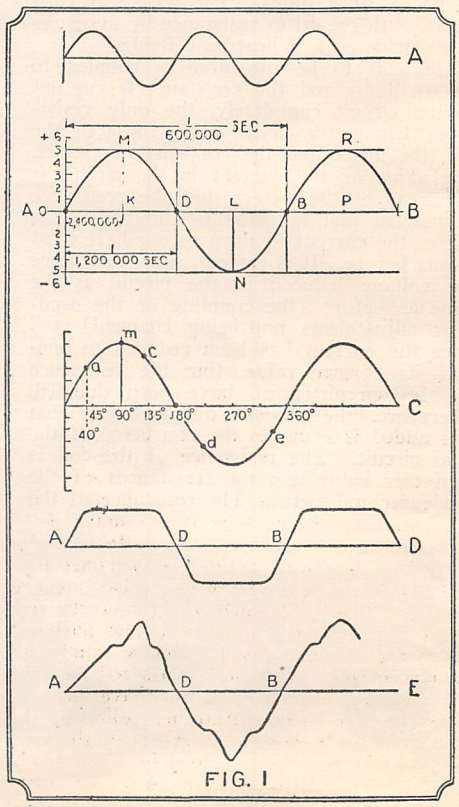
PITCH AND QUALITY OF SOUND

There is a close analogy to this condition in the case of sound waves in air where it is quite possible to have two notes of the same pitch (frequency and wave-length) which sound very different—the middle C for instance sounded on a violin and the same note produced from a saxophone. The sound waves from the two instruments will be of precisely the same length but of different shapes. The quality or timbre of a musical sound depends on the shape of its wave as determined mainly by the number and relative prominence of the overtones present in it. In a somewhat similar way the "electrical quality" of an electromagnetic wave depends on its shape as determined by the electrical constants of the circuits producing it. For efficient and economical operation of radio sets of high power, control of the wave form is as important as control of the wave-length.

The considerations outlined above serve to show the necessity for instruments designed to record the shape of radio waves. It will be remembered (see Fig. 1, B) that one of these waves is completed in a half of a millionth to two millionths of a second, depending on its length, and it is at once apparent that no instrument of ordinary design with a pointer moving over a scale or with a swinging mirror will be of any use. Such instruments have so much inertia that they cannot "get under way" in a millionth of a second. The fact is that only one type of instrument known to the physicist has proven of any value in this connection and that is the *cathode-ray oscillograph.*

CATHODE RAYS ARE ELECTRONS

The idea back of this instrument is a very simple one and the way in which it performs is so very beautiful that it is worth a little study. The essential part of a cathode ray oscillograph is a beam of cathode rays shooting down the axis of an elongated vacuum tube. Cathode rays are nothing more or less than ordinary electrons. In practical oscillographs the electrons to make up the beam may be produced either from a cold cathode or from a hot cathode. Oscillographs of this kind are consequently grouped into



Various kinds of curves used in radio, showing voltage or current against time.

*Professor of Experimental Physics, University of Pennsylvania.

two classes depending on the type of cathode. Fig. 2A represents diagramatically a cold-cathode tube and Fig. 2B a hot-cathode tube. They look very much alike. At A in both tubes is the anode which is a metal plate supporting at its center at right angles a tube, T, about one centimeter long, with a fine bore of perhaps one-tenth of a millimeter. In the cold-cathode tube the dis-

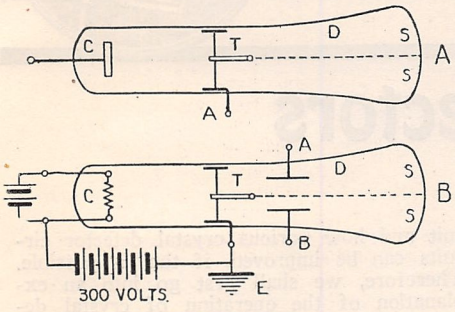


FIG. 2

The simple cathode-ray oscillograph is shown at A, while at B the tube is shown equipped with two sets of deflecting plates.

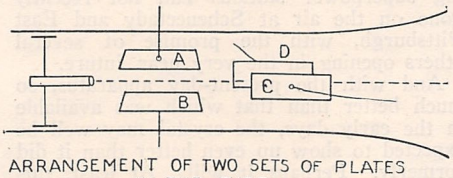
charge is maintained by electrons liberated at or near the cathode by positive ion bombardment, as explained in RADIO NEWS in an earlier article of this series on cold-cathode tubes. This action requires a high voltage between anode and cathode (6,000 to 10,000 volts)—an undesirable feature. In the hot-cathode tube the electrons are produced from a hot filament. Such tubes operate on 300 to 600 volts between anode and cathode. The advantages of this type of tube are so great that they are used at the present time almost to the exclusion of the earlier cold-cathode pattern. Some of the electrons striking the anode fly through the bore of the tube T, which although small to us, is enormously large to the electrons, and come out into the space, D. The anode is earthed so that there is no electrical force in the space D and the electrons move directly across it with the velocity they had when they came out of the tube and strike on the end wall. If proper precautions are taken a neat, narrow beam of electrons can thus be produced, passing directly along the axis of the vacuum tube. If there is a small amount of gas in the tube the path of the electron beam is readily seen through a bluish luminosity which is produced from the gas molecules when they are struck by the electrons. To show the point of impact of the beam the end wall of the tube is coated inside with a layer of some chemical, for example, calcium tungstate, which fluoresces under electron impact (SS, Fig. 2). No matter how high the vacuum in the tube, the position of the end of the electron beam is then always indicated by a brightly glowing spot of light although with the high vacuum, the *path* of the beam is invisible.

ELECTRIC AND MAGNETIC DEFLECTIONS

Now, we know these electrons to be particles of negative electricity. When moving as they are in this case a stream of electrons is essentially the same as an electric current although here the usual conducting wire is not present. Such an electron stream can be deflected by a magnetic field and it can also be deflected by a charge of static electricity—a negative charge repelling it and a positive charge attracting it. The effect of the magnetic field can readily be demonstrated merely by bringing an ordinary bar magnet near the tube. The spot of light on the end wall will instantly move to a new position. Bringing a static charge, such as might be produced by rubbing on a glass rod, outside of the tube will not, however, have any noticeable effect, since electricity collecting on the inner walls of the tube serves in all cases as an effective shield. To deflect the beam with a static charge it is necessary to introduce a couple of metal plates inside the tube. Let these be placed at A and B in the figure (Fig. 2B). First let B be earthed by connecting it to the earthed anode and then charge A positively. The beam will instantly be drawn toward A, as will be evidenced by the movement of the spot of light on the end wall. If A is charged negatively the beam will be repelled. If A be connected to one side of an alternating current supply line so that it charges up alternately positively and negatively 60 times a second, the spot of light will vibrate up and down 60 times a second. Of course, this motion will be too rapid for the eye to follow so that one sees merely a line of light on the end wall instead of a spot.

THE WAVE FORM PICTURED

In order to bring out the wave form of the 60-cycle supply the spot of light must be moved sideways at a proper rate at the same time that it is moving up and down. If, for instance, when the spot starts down from M to N (Fig. 1, B) it is moved sideways a distance KL—then while it is going up from N to R it is moved the distance L to P sideways, the spot will actually trace out the path MDNBR, as drawn. If when the spot moves down next time it goes back sideways from P to L and then on the next upstroke from L to K and repeats, the spot will continually travel back and forth on the curve drawn. Due to the persistence of the fluorescence in the screen and to the persistence of the image of the spot on the retina of the eye—just as when a lantern is swung in a circle we see a ring of light—the full curve will stand out steadily on the end wall of the tube looking very much as it is drawn in Fig. 4. The necessary sideways movement of the beam to give a steady figure must



ARRANGEMENT OF TWO SETS OF PLATES IN THE TUBE

FIG. 3

Two sets of plates make it possible to deflect the cathode beam in two directions, giving the Lissajou figures in Fig. 4 below.

evidently be very accurately tuned or "synchronized" with the vertical motion caused by the charges on the plates so that the spot will move over the exactly same path on the fluorescent screen during each cycle. The sideways deflection can be brought about by inserting a second pair of plates in front of the first pair and at right angles to it, as shown in Fig. 3. One of these plates is earthed, while the other one is connected to a device for making the charge on it vary in the way necessary to bring about a suitable sideways deflection. It can be seen from Fig. 4 that if the curve on the screen is to give an undistorted picture of the wave as we have defined it—that is, of the variation of the electric force on plate with the time—the sideways displacement must be at a uniform time rate throughout its motion in both directions; it cannot be a sine-law motion, such as would be produced by applying an ordinary alternating potential to the plate.

HOW RADIO WAVES ARE HANDLED

Although arrangements can be made to produce this uniform sideways displacement, tuned accurately to the period of the alternating potential on plate A, for low frequencies, like the 60-cycle circuit here under consideration, it has not been found practical to bring about exactly similar results for the high frequencies of radio waves.

In dealing with radio waves, therefore, we cannot get an exact picture of the wave form standing out on the screen. We can, however, get a figure from which the wave form can readily be calculated. This is done by applying a sine wave sideways displacement to the beam by attaching the second pair of plates to an oscillating tube circuit with a known wave form, at the same time that the first pair of plates is connected to the circuit under investigation. The figure traced by the cathode ray beam under these conditions looks complicated, but it can always be unravelled and expressed by a plot of intensity against a uniform time scale.

The compound figures produced when two oscillating tube circuits act at the same time on the cathode ray beam have useful applications also in measuring frequency and in synchronizing or "bringing into step" two or more circuits. Suppose plate A is connected to one side of the condenser of an oscillating circuit (1) and that plate C is connected to the condenser of a second oscillating circuit (2) the frequency of which is twice that of circuit 1. Let circuit 1 deflect the beam up and down and circuit 2 deflect it sideways. While, due to circuit 1, the beam is travelling from A to B (Fig. 4A) it will, due to circuit 2, travel from A to C and back again. The actual path traversed will thus be ADB and the figure on the screen will be the curve ADB. If the first circuit has a frequency three halves as great as the second, the figure traced will be as sketched in Fig. 4B. No matter what the frequency ratio is, provided it is a whole number ratio, a characteristic figure will be formed which, after a little practice, can be recognized at a glance.

SYNCHRONIZING CIRCUITS

If the frequency of either circuit alters even by a fraction of a single cycle in a second, the figure immediately begins to alter to a new form—it starts to move. A stationary figure is therefore a most delicate test of a steady frequency ratio. If we have to begin with a low frequency standard circuit of which we know the frequency—and such low frequencies are very easily measured—we can thus adjust other circuits with great precision to any desired higher frequency by bringing out the proper luminous figure in our oscillograph. Such figures, produced by the simultaneous action of two oscillations, the periods of which have a whole number ratio, are called *Lissajou figures.*

Another use of this instrument is to show visually the "characteristic curves" of vacuum tubes. Take, for example, the grid voltage-plate current curve. Here we have to show on the screen the variation in grid voltage and the associated resultant variation in plate current. If we attach plate D to the grid of the tube the sideways movement of the cathode ray beam will be proportional to the grid voltage. We must next arrange to have the up-and-down displacement of the beam proportional to the plate current. The best way to do this is to place outside the tube a pair of wire coils (as shown in Fig. 5) through which the plate current can flow. The current in these coils produces a magnetic field, proportional at all times to the current strength, which deflects the beam in the desired up-and-down direction. In this arrangement we make no use of plates A and B (Fig. 3). So the grid voltage rises and falls, the plate cur-

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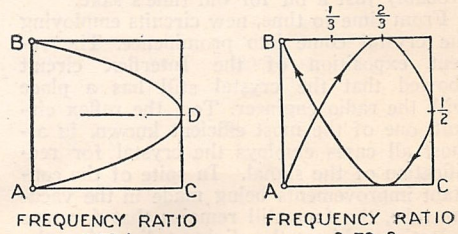


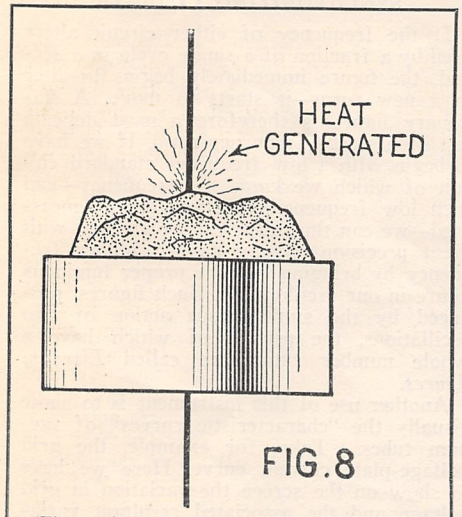
FIG. 4

These are Lissajou figures for determining frequency and wave form.

All About Crystal Detectors

By A. P. PECK

BEFORE going into the actual operation of crystal detectors—the how and why of them—it might be well to say a few things which may serve to place them in their proper place historically in the minds of the newcomers to the radio field. In these days with vacuum tubes at prices within the reach of almost every experimenter, it is hard to realize that at one time, practically all the radio communication of the world, amateur and professional, was carried on through the agency of this lowly device. As a matter of fact, there was a time in the early history of the



The action of a crystal detector may be explained by the heat theory, as detailed in the text.

art when the crystal detector was considered a boon to the receiver.

At present, on account of the development of the vacuum tube and the reduction in its price due to the advance of manufacturing methods, the crystal detector has become somewhat of an outcast—at least with the amateur and the broadcast listener. With the commercial operators, it is still used to some extent and is always held in reserve as emergency equipment. When they are called upon to work local stations, in heavy interference, it is often resorted to on account of its extreme stability—and probably just a bit for old time's sake.

From time to time, new circuits employing the crystal come into prominence. The recent exposition of the Interflex circuit showed that the crystal still has a place with the radio engineer. Too, the reflex circuit, one of the most efficient known, in almost all cases employs the crystal for rectification of the signal. In spite of the constant improvements being made in the vacuum tube, the fact still remains that for true detection, without the slightest distortion, the crystal remains superior to all other devices.

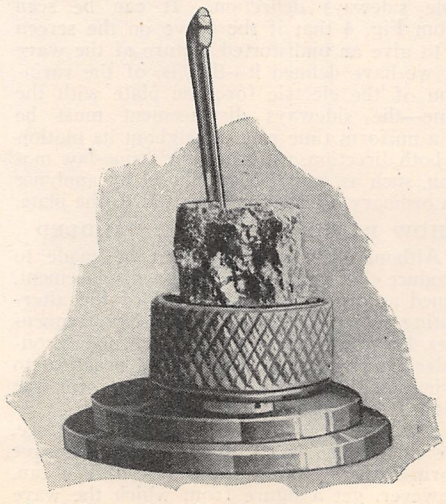
Again referring to RADIO NEWS, there was a description some months ago of a crystal oscillator. This puts it almost on a level with the tube. Of course, this last point has not been investigated as thoroughly as possible, but the possibility is there none the less.

One of the frequently heard criticisms of the crystal as a radio receiving detector is its lack of sensitivity. This seems like a false indictment to many of the old-timers in the game who formerly listened, night after night, to the time signals and press from the Navy stations on the two coasts, with nothing but a big aerial and a crystal detector with phones. These old-timers used to cover distances up to fifteen hundred miles pretty regularly when receiving from the high-powered stations.

Of course, the comeback always is that the transmitters were using huge power inputs and that the reception was all in code. This is a valid criticism, or might be if the big superpower stations had not recently gone on the air at Schenectady and East Pittsburgh, with the promise of several others opening in the very near future.

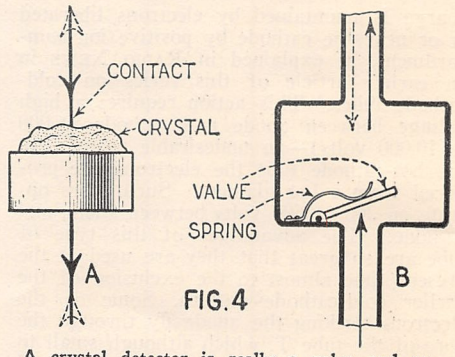
And with the present-day apparatus, so much better than that which was available in the early days, the crystal may well be expected to show up even better than it did formerly. Perhaps it will. At least, this article will show those who wish to learn something of the operation, care and use of this lately neglected piece of radio apparatus, the way in which they might use it and possibly find an excellent radio set at a small fraction of the cost attached to the vacuum tube variety.

One of the main reasons for the following rather lengthy exposition on crystal detectors in general is the fact that so many of the readers of RADIO NEWS have shown their interest in another article on the subject of crystal detectors that appeared in the November issue of RADIO NEWS. It seems that many of these readers are very desirous of finding out just how a crystal detector works, what takes place in the circuit and how various crystal detector circuits can be improved, if that is possible. Therefore, we shall first go into an explanation of the operation of crystal detectors and rectifiers, as they may be called, and in as simple language as possible explain just what takes place.



An ordinary piece of crystal, such as that used in a crystal detector for radio work, is shown in the above photograph.

First, we probably all remember from the



A crystal detector is really a valve and an analogy is given above.

various other articles published in the Radio Beginner's section that a current, the picture of which looks like that shown in Fig. 1, is received by the aerial and passed on to the detector circuit. Since this action has been explained before we shall not go into it in detail at this time. It is sufficient to say that a current of the type illustrated is what is known as a radio frequency oscillating current. In its present form, that is, before it is detected or rectified, it cannot operate a pair of receivers or a loud speaker. The reason for this is that the current is flowing first in one direction and then in the other very, very rapidly. These changes of direction, or oscillations as they are called, are taking place thousands of times per second. If a current of this nature were to pass through a pair of phones there would be as much "pull" on the diaphragm as there would be "push." In other words, the changes in current would follow each other so very rapidly that the diaphragm would not vibrate and therefore would not set up sounds that could be heard by the ear. Therefore, in order to make a radio current audible, it is necessary first to change it in some way. This can be done by means of some type of detecting or rectifying device such as a vacuum tube or crystal detector. Since in this article we are interested only in the latter, we shall discuss its action only. Just what the detector does is to allow current flowing in one direction only to pass through it. This flat statement must be modified somewhat as a detector will allow a very minute amount of current to flow in the other direction, but for all practical purposes we can say that the rectification is complete and that current flowing in one certain direction only can pass.

When this is done by means of a detecting device, the current curve resulting is similar to that shown in Fig. 2. It will be noticed that all the current flowing in the opposite

direction from that indicated above the horizontal line has been eliminated and that only uni-lateral or single direction current has been passed by the crystal detector. This series of impulses or fluctuations of current is still too rapid to actuate the diaphragm of a pair of receivers because the diaphragm cannot respond as rapidly as they fluctuate and, therefore, their effect might be termed as accumulative. Every train of waves gives an impulse to the telephone diaphragms in the form of the curve shown in Fig. 3.

By referring to the article in the last issue of RADIO NEWS, detailing the operation of a broadcast station, we find that each sound wave modulates or controls the current at the transmitting station and that each train of waves set out from the antenna of that station takes the form of the particular syllable or other sound that was impressed upon it. This form is still maintained at the receiving end and each one of the fluctuations affect the diaphragm of the receiver as in Fig. 3.

The action of a crystal detector in a radio receiving set might be likened to that of a one-way valve in which a flow is allowed in one direction but not in the other. Fig. 4A illustrates a crystal detector with a cat-whisker contact. Current flowing in the direction indicated by the solid arrow-heads can pass quite readily through the instrument. When, however, the current changes its direction of flow, as indicated in Fig. 1, it cannot pass through the crystal, as shown by the dotted arrow-heads and, therefore, it is stopped and the result is a current curve such as shown in Fig. 2. A valve action that will explain this a little more fully is shown in Fig. 4B. Here an ordinary flap valve is used and when water flows in the direction of the solid arrow, it will push the valve open and continue on its way. If, however, water comes in in the direction of the dotted arrow, it will merely force the valve closed and, therefore, cannot pass out through the other pipe.

By this time you have probably begun to wonder how the various facts outlined above have been determined and how the working qualities of crystal detectors are determined in the laboratory. We shall explain this method here and it is well to follow it carefully so that you can fully understand some of the explanation given later in this article.

In the laboratory, apparatus is set up and connected as shown in Fig. 5. First, we have a battery or other source of direct current and placed directly across it is a potentiometer. The arm of the potentiometer is connected to the crystal detector, and a volt meter and very sensitive ammeter are connected in the circuit as shown. Sometimes the ammeter is replaced by a sensitive calibrated galvanometer because the instrument must be able to show very minute currents which come to it after flowing through the crystal detector. If now the current is turned on, both of the meters, V and A, will show readings. For a given volt meter reading there will be a certain reading on the ammeter or galvanometer. If, however, the battery connections are reversed and the current is caused to flow through the crystal detector in the opposite direction, the ammeter readings will not be the same for a given volt meter reading as they were with the other battery connection. This shows that the crystal detector passes current much more readily in one direction than in the other and, therefore, indicates its rectifying action, or its ability to act as a valve such as that shown in Fig. 4B.

Some of the curves that can be plotted by means of an instrument layout such as shown in Fig. 5 will be interesting if studied carefully, together with the following explanation. In Fig. 6 we show an arbitrary curve of this nature. The vertical line divided in the center represents increases in voltage from zero in one direction and from zero in the other direction. The horizontal line indicates an increase of current from zero at the left. If now a voltage is applied to the crystal detector in a certain direction as, for instance, in this case indicated by the plus sign, the current will increase greatly as the voltage increases. This shows that current is flowing freely through the circuit.

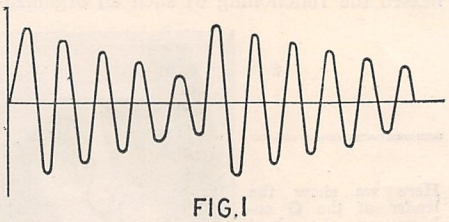


FIG. 1

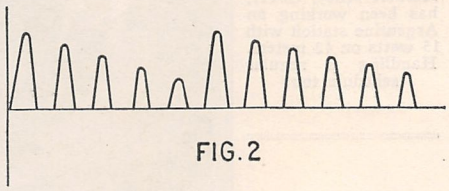


FIG. 2

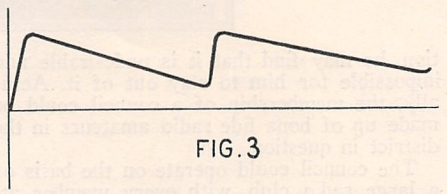


FIG. 3

Figs. 1, 2 and 3 aid in the explanation of the action of a crystal detector.

Now when the battery is reversed, as in the experiment shown in Fig. 5, or when the radio frequency current reverses as indicated by the graph in Fig. 1, the voltage and current flow, in the opposite direction and a given increase in the former results in only a very small increase in the latter. This again shows the rectifying or valve action of the crystal.

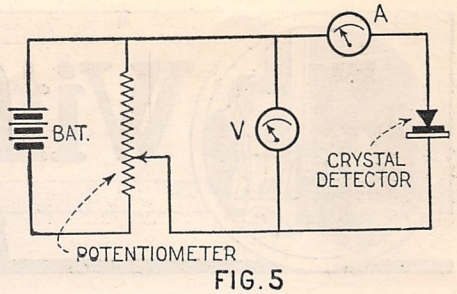


FIG. 5

This diagram shows how the electrical characteristics of a crystal detector are determined in the laboratory.

In Fig. 7 we show still another curve that indicates when a crystal detector is good and when it is not. If for instance, we have a crystal that passes current just as readily in one direction as in the other, no rectification action will take place because the current such as shown in Fig. 1, when it passes through the detector, will have the same characteristics and therefore, as described above, cannot affect the phones. A curve that can be readily grasped and which shows the action of a poor detector is shown as line A in Fig. 7. Here the voltage and current at point E are the same as the voltage and current at point F, even though at point E the current is flowing in one direction and at F in the other. We see that the lines from O to A above the voltage line, and to A below the voltage line, are symmetrical and practically the same in all respects. This symmetry shows a lack of rectifying action. Now, however, if we were to plot the curve of a good crystal detector, we should have something like the line BOB. When the current flows in one direction, as above the voltage line in Fig. 7, a given increase in voltage makes a very small change in current. Note how close the point C is to the line indicating the current flow. Now referring to the curve which shows the current and voltage when flowing in the opposite direction, we find point D indicating a certain increase in voltage and also indicating a correspondingly great increase in current. Thus we see that the curve from O to B above the voltage line is not similar to that from O to B below the voltage line and that the crystal detector action has taken place and that the crystal detector in the circuit is a good one. In other words, it nearly stopped the current in one direction but allowed it to flow quite freely in the other.

Strange though it may seem to say a thing of this nature, little is known about the actual reason why a crystal detector works. It would seem that such a simple little instrument could be quickly and easily

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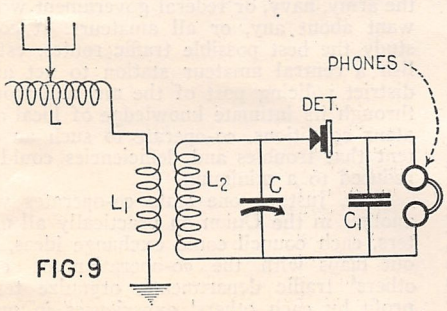


FIG. 9

Well-designed crystal detector receiving sets will give most exceptional results. The particular part of the circuit that must be given the most attention is that which includes coil L2 and condenser C in Fig. 9 above. Details on this work will be found in the text.

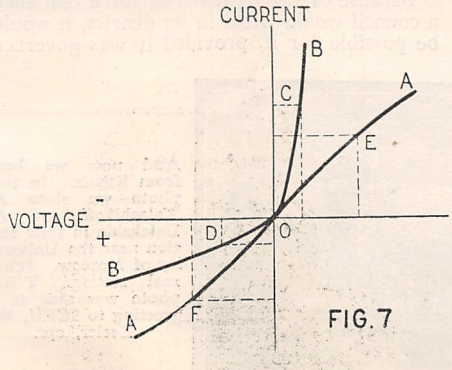


FIG. 7

This curve shows the characteristics of both a good and a worthless rectifying crystal.

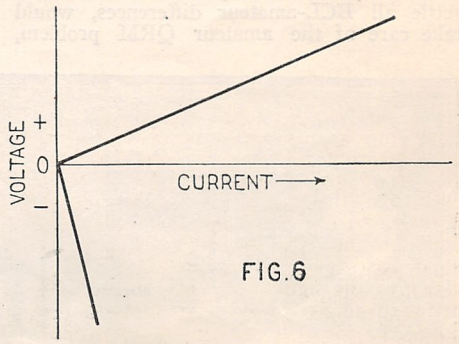


FIG. 6

Another way of indicating the relative values of crystals for detection purposes is illustrated above. The curves are completely explained in the text.

Amateur Radio Organization

By LLOYD JOCQUET, 2OZ

AMATEUR radio organization grew with the game. As we tried our wings, we tried for distance. Then the possibilities of traffic work were seen, and relay routes were mapped out. Standardized methods of receiving and transmitting were worked out so that amateur radio would really serve its purpose.

After fifteen years of amateur radio, it is a question at this day whether the methods impressed in emergencies, and the regulations worked out at a time when present amateur development was unforseen, really represent the progressive spirit of which the amateur has so often boasted.

To cope with the big problems which face the freedom of the radio amateur, organization is necessary. The amateur must present to well-organized and rich commercial groups a front which is just as sturdy.

DISTRICT WORK

To accomplish the aim of true amateur radio representation, and to enlist in the work or recognition all of the forces available, other means than those practised so far should be studied. The ideas submitted here, which are thoughts on the subject, and are written primarily to suggest other ideas.

As every amateur knows, the United States is divided, for purposes of radio administration, into nine Federal radio districts. Each district forms a unit which could be the basis of amateur self-government.

The idea is to have in each district, or in a similar territorial division, such as a traffic division, a governing body which would be related to a national body in very much the same way that the federated states of the Union are in relation with the Federal government in Washington.

In other words, each district would have its own autonomous body of representatives, such as a radio council. This council would elect its own district president, district vice-president, and so on, and have its own local traffic manager, and other officers necessary for the administration of the district or division, so far as the purely secretarial and desk business is concerned.

The division or district council—whatever you choose to call it—would have full authority and supervision over amateur radio matters within its own jurisdiction. It would settle all BCL-amateur differences, would take care of the amateur QRM problem, would co-operate with the supervisor's office, and, briefly, would be to the district what the police or engineering departments are to the states in those respective branches.

SUGGESTIONS

Just how the membership of such a council could be recruited is not of great moment. Suffice it to say that every amateur would no doubt consider it a duty to belong to the governing body of his district or division. In fact, it may appear that after he has witnessed the functioning of such an organization, he may find that it is undesirable and impossible for him to stay out of it. Actually, the membership of a council could be made up of bona fide radio amateurs in the district in question.

The council could operate on the basis of a large radio club, with every member attending the meeting, or it could be made up of delegates from the dozens of radio clubs located in that locality. This last thought is to preserve the movement and identity of the radio clubs, which have not had a chance to do their best work, and whose growth has been somewhat discouraged. In either case, efficient representation of every amateur would be assured in a manner now not possible.

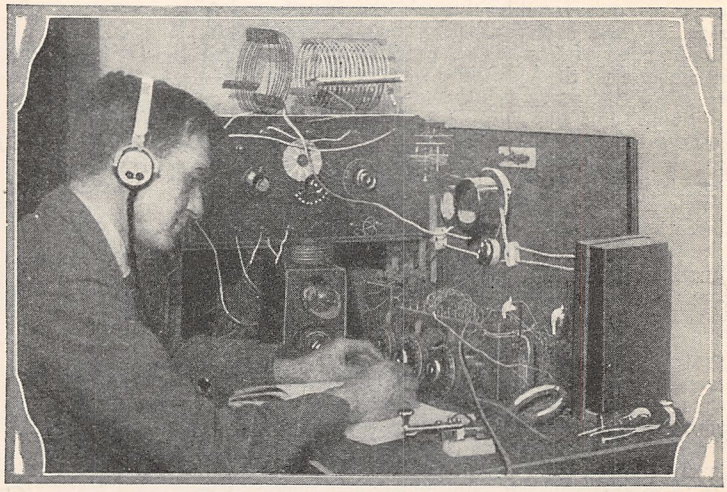
Because of the tremendous force that such a council would wield in its district, it would be possible for it, provided it was governed by responsible and capable men, to make the radio amateur one of the strongest factors in its community. In the first place, a drive could be made for the building of a district club headquarters. A fund, for which subscriptions from every source could be sought, would quickly bring about the realization of that dream—a real amateur radio club house!

Why haven't we had more amateur club houses? I don't believe I ever heard of an amateur organization actually possessing such a thing. And yet, there are thousands of fraternity houses all over the country, and other organizations such as the American Legion, the Elks and golf clubs. Such groups have in many towns, small palaces.

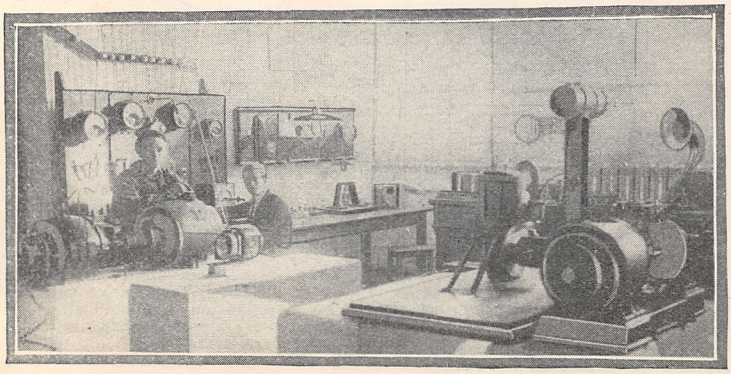
Once the radio amateurs find their place in the communities they will be respected and looked up to. After the first effort of getting a concrete evidence of the earnestness of the council, amateurs of the district will support it strongly, provided it carries out ideas and suggestions that will benefit the amateur radio field. By dues and levies, a council would be in a very good position to secure funds, without which it is next to impossible to do really constructive work.

The council could compile all of the information about the district that any agency, the army, navy, or federal government would want about any, or all amateurs. It could study the best possible traffic routes, establish a central amateur station to act as a district policing post of the air, and would, through its intimate knowledge of local amateur conditions, co-operate to such an extent that troubles and defficiencies could be reduced to a minimum.

Now, just as one state co-operates with another in the Union on practically all matters, each council could exchange ideas, lay out maps with the co-operation of each others' traffic departments, organize tests; profit by each others' experiences in many ways. There could even be loans made, men exchanged, and material placed in those parts of the country where an emergency would make it necessary to preserve and continue good amateur radio.



Here we show the leader of the G cohorts on the short wave-length. Mr. Herbert Hiley, G2IH, has been working an Argentine station with 15 watts on 42 meters. Handling a regular schedule too!



And now we hear from Russia. In this photo we show A. Kalachikoff and A. Balakshin in their station near the University of Moscow. It's a real station. The photo was sent as a greeting to 9CFU, W. Beeler, opr.

Not in an attempt to be militaristic, but to show how the council idea would fit in with the recent naval and military appeals from Navy and Army Departments, think of the potentiality of really, truly organizing entire units of the signal and radio corps, made up entirely of amateurs. The companionship that would result, and the co-operation that amateurs would really be in a position to give the two branches of the service would show the power of the amateur.

Now let us see how this idea fits in with the national scheme of things. For the national government of the radio amateur, a national council, made up of delegates, or officers of division or district councils, would meet to discuss matters of national importance. In fact, a national bureau might be installed and supported by tax on each council in a central point, say Chicago. This national bureau could function in the same way that the Federal Government of the United States works in Washington. Except, of course, that there would be no Congress and other machinery of legislative type, but just executive power, which would be transmitted to it through the individual councils.

Representation of this type would be truly national. Better reports on local conditions, exchange of ideas, possibly of funds, true facts, unbiased and uncolored, less amateur difficulties and friction and greater co-operation with the district supervisors are only some of the points that this council idea would foster.

In the case of the national radio conferences that have been held at Washington, amateurs were represented as best they could by a few men who fought well for the rights of the entire country. But how much

(*Continued on page* 1093)

Here is one of the most powerful ham stations in South America. Note the foreign apparatus, probably of French origin. Ernesto Stricker is owner and operator of the outfit. It punches 1,500 watts into the aerial.

The Third National Amateur Convention

By DAVID TALLEY, 2PF

THE Third National A. R. R. L. Convention, held in the Edgewater Beach Hotel at Chicago from August 18th to 21st, was attended by amateurs from every part of the United States and Canada and even one from England, namely, G6GZ. Over 700 amateurs were gathered in conference during the week.

As our story deals with the Hudson Division delegation, we shall begin by introducing the characters:

2ND DISTRICT REPRESENTATIVES

U. B. Ross, 2UD, representing the Radio Club of Brooklyn; Frank Frimerman, 2FZ; Jack Berliant, APV, representing the Bronx Radio Club; Edward Wilbur, 2BNL, representing Manhattan and 2AHO, 2CO and 2CTQ, from Jersey. The writer represented the Hudson Division manager, Edward M. Glaser, 2BRB. 2BEN and 2BLM came as transients from the Bronx.

As a prelude, the adventures of 2UD, 2BNL and 2PF will be described:

We left Penn. Station bright and early in the morning after being driven to the station by 2BRB in 2 PF's car and making the train with hardly a moment to spare.

The first stop was Pittsburgh, after such incidental short stops as Philadelphia, Harrisburg, etc. While *en route* on the train, we tried receiving and transmitting on the portable transmitter and receiver built by 2UD. This set was contained in three boxes, the smallest but heaviest box containing the 112 volts of "B" batteries and 4-volt dry cells. Needless to say, the writer carried the smallest box most of the trip. Nothing was heard on the receiver except QRN, due, no doubt, to the coal mines and mountains through which the train was passing. By courtesy of the radio inspector in the Second District, our friend Mr. Arthur Batchelor, the call letters of the portable transmitter were assigned as 2AUD.

THE CITY OF 1,001 SMOKES

Upon arriving in Pittsburgh, we went to the Hotel Henry (the place was recommended by 2CYX, the famous traveling salesman from the Bronx Radio Club, so it must be good).

The manager was rather astounded when we asked for one room and three baths, but a hasty compromise assured us that he could supply us with one large room and a single bath. We certainly needed the latter, since Pittsburgh has never been under-rated.

In Pittsburgh we visited 8OW and 8COV and after "chewing the rag" with some of the fellows back home, we went back to the hotel, shook the coal dust off ourselves and, in the morning, resumed our journey.

We arrived at Fort Wayne late in the afternoon and were met by 9CKL, who took us around in his car to visit quite a number of stations in town, including 9II, 9DKP and 9CKJ, fellows with whom we had spoken over the air *via* amateur radio from back home. Although our room at the hotel was none too large, we invited eight of them to join us, and about 3:30 in the morning, at the request of the management, they left. (A good time was had by all!)

"CHI"

The next morning we took the train once more and, after a steady ride, arrived that afternoon in Chicago, where we were met by 2FZ and APV in the latter's big Studebaker, painted a maroon color, which made all the natives (we were in Chicago all right) QRX. We made a wonderful impression on the Chicagoans. A short parade

(*Continued on page* 1032)

Here are three of the gentle knights of the Brass who championed the Hudson Division at the recent National Amateur Convention held in Chicago. Their experiences are detailed in the accompanying article.

Awards of the $50 Radio Wrinkle Contest

First Prize

HOME-MADE VERNIER CONDENSER

By Edward Smith

One of the handiest pieces of apparatus for the experimenter is a vernier condenser of fairly small capacity. The one described below will fill the bill and is easily made from pieces of apparatus that can be found in the well-known junk box.

The materials necessary for the construction of this vernier condenser are as follows:

1 glass tube, the outside diameter of which is 1 inch, with a cork to fit. This tube should be 3¼ inches long.

1 strip of sheet copper, No. 26 B. & S. gauge, 7 x 1 7/8 inches.

1 brass bolt, ¼ x 1¼ inches; two nuts and washer to fit.

1 binding post with 5/32-inch bolt and insulated cap.

1 piece of No. 12 B. & S. gauge copper wire 4 inches long.

The end of the glass tube, 12 inches in length (see diagram) is flared out a little by holding the tube in a hot gas flame and revolving it while flaring out the end with the end of a file. The length of the tube is then cut to exactly 3 inches from the end of the flared part. This may be done by cutting a line around the tube with a file and gently tapping the tube until it breaks around the filed line. From the strip of sheet copper, cut a pattern as shown in 11-A. Bend this as shown in 11-B and slip over the glass tube in the position 11 in the diagram. Now bend the soldering lug, 14, over the flared end of the tube. This prevents the copper band from slipping and is also used to connect this plate of the condenser to the circuit. From the copper strip another pattern, as shown in 10-A, is cut and bent to shape as shown in 10-B. This is the sliding plate of the condenser and is placed inside the glass tube as shown at 10 in the diagram. The combination washer and soldering lug is also cut from the copper strip, as shown at 7-A.

A ¼-inch hole is drilled in the cork, 8, the length of which is 3/8 of an inch. A hole is drilled lengthwise through the ¼-inch brass bolt, 4, to accommodate the shaft, 3. The diameter of this hole is 5/64 of an inch. The end of the bolt is slottered ¼ inch deep, as shown in 4-B. This leaves four prongs, which are bent in the direction of the hole, the purpose being to insure good contact on the shaft, 3.

Cut a piece of No. 12 B. & S. copper wire 3 9/16 inches long and bend to the shape shown at 3-A. Slip the shaft, 3, through the bolt, 4. The bolt, 4, is screwed through the cork, 8, and the washer, 15, placed on the side of the bolt that is slotted. The nut, 9, is then run down on the bolt over this washer. Drill a 5/64-inch hole through the 5/32-inch bolt, 2. This bolt should be about ¼-inch long and is put on the shaft, 3, where it is soldered and the binding post nut, 1, is screwed on it. Do not solder on the bolt, 2, before putting the shaft through the other bolt. The shaft, 3, is now soldered to the copper band, 10.

The condenser is now ready to mount on the panel and this is done by drilling a ¼-inch hole in the panel and inserting the bolt, 4, and tightening the nut, 5. Caution should here be used as the cork will expand as the pressure is increased and may break the glass tube. The binding post top, 1, is then screwed on to the bolt, 2, and the condenser is now ready for operation. This is done by sliding the handle, 1, in and out. It should work very smoothly for best results.

Prize Winners

First Prize $25
HOME-MADE VERNIER CONDENSER
By EDWARD SMITH
276 9th St. Astoria, Ore.

Second Prize $15
RADIO RECEIVER BASE
By HUGO E. ANDERSON
340 E. Tamarack St., Ironwood, Mich.

Third Prize $10
HOW TO ERECT A ONE-MAN ANTENNA MAST
By R. WILLIAMS
Box 553, Edmonton, Canada.

NOTE: The next list of prize winners will be published in the March issue.

Second Prize

RADIO RECEIVER BASE

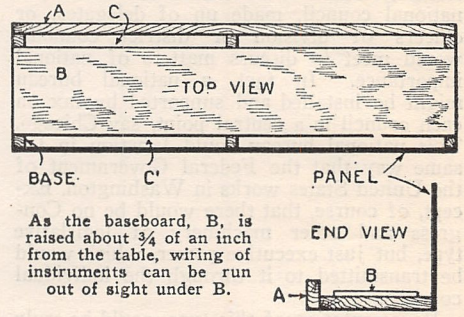
By Hugo E. Anderson

One of the greatest difficulties that is experienced in wiring a radio receiver is keeping the connections as short as they should be and at the same time producing a neat job, which is efficient electrically. The base that is described below is easily constructed and should make the wiring job of the new set a great deal easier.

The dimensions of length and breadth are purposely omitted, because they would differ for every set constructed. However, the spaces marked C and C¹ should be about ¾ of an inch in width and the back piece, A, should extend ¾ of an inch above the base, B.

The back piece, A, may be used to mount strips on which to support coils, binding posts, etc.

The reason for the thin baseboard, B, is to facilitate wiring and mounting of the various instruments. A great deal of the wiring may be done under the thin baseboard as well as on the top of it, thus eliminating any danger from short circuits and unnecessary long leads. The transformers, sockets and other instruments may be fastened to the baseboard by small nuts and bolts.



As the baseboard, B, is raised about ¾ of an inch from the table, wiring of instruments can be run out of sight under B.

Third Prize

HOW TO ERECT A ONE-MAN ANTENNA MAST

By R. Williams

Instead of calling in a fire brigade or all of your wife's relations when you erect your antenna mast, by following this procedure, you will be able to do the job all by yourself.

For a mast 38 feet high the following material will be needed:

1 piece 1 x 2 inches, 16 feet long.
2 pieces 2 x 4 inches, 20 feet long.
1 piece 4 x 4 inches, 20 feet long.
2 iron bolts ½ x 8 inches.

Have the 4 x 4 tapered for 16 feet down to 2 x 2 at the small end, leaving the other 4 feet full size. If you wish to paint your mast, which is a good idea, have this material dressed.

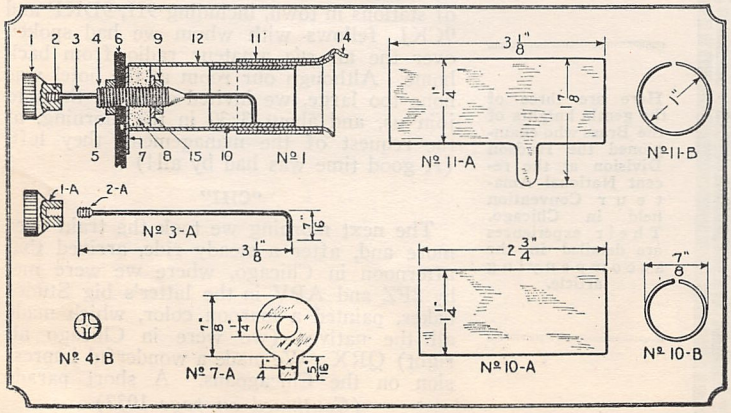
Lay one of the 2 x 4's flat on the ground at the site where you wish your mast to be raised. Place the large end of the 4 x 4 in line with it with an overlap of 2 feet and lay the remaining 2 x 4 directly over the bottom piece. Through the three pieces of wood bore two holes of such a diameter that they will take the ½-inch bolts 18 or 20 inches apart. The bolts are then placed in the holes and tightened up.

Now spread the free ends of the 2 x 4's about two feet apart and nail 1 x 2 strips ladder-wise about 18 inches apart. Your mast should now resemble Fig. 1.

Now remove the bottom bolt, attach your antenna wire and permanent guy wires to the top of the mast and temporary guy wires or ropes to the top step of the "ladder." Then tie a piece of stout rope about 25 feet in length to an odd piece of 2 x 4 about 16 feet long and nail or lash the other end of it to the bottom end of the top part of the mast. This is a counterpoise or lever and is removed when the job is completed.

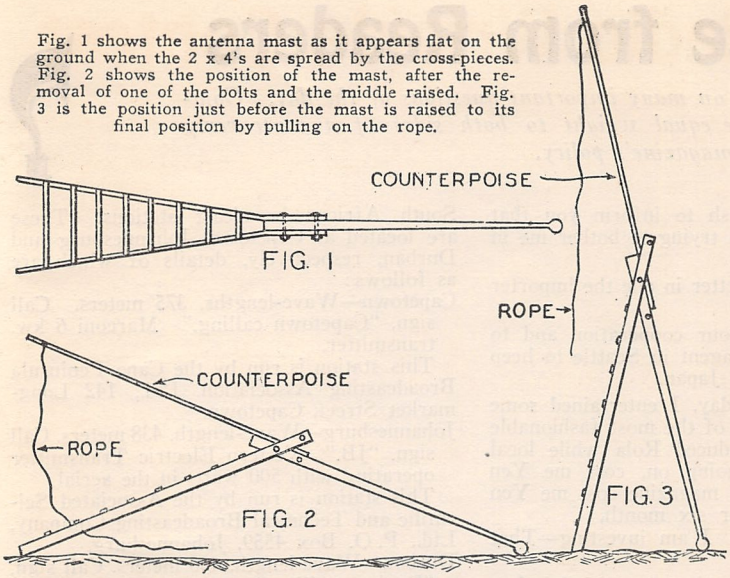
Now stand in the center over the remaining bolt, which acts as a hinge, and lift the assembly as high as you can in this way. This should take the form of Fig. 2.

Now take the top of the mast, which is resting on the ground, and carry it toward the base until it is almost straight up. Place the end of the mast on the ground and guy the base with temporary stays in this position. You now have the top of the mast and the temporary counterpoise balanced as in Fig. 3.



On the left is a detailed drawing of the parts for the vernier condenser, that is described above. The glass tube, inside of which slides one of the tubular plates, is the dielectric of the condenser. Each figure is explained in the text.

Fig. 1 shows the antenna mast as it appears flat on the ground when the 2 x 4's are spread by the cross-pieces. Fig. 2 shows the position of the mast, after the removal of one of the bolts and the middle raised. Fig. 3 is the position just before the mast is raised to its final position by pulling on the rope.



The top half of the mast is then raised to its correct position by pulling on the rope, which is dangling at the end of the counterpoise. Tie the counterpoise close to the ladder at the bottom of the mast and peg down loosely your permanent guy wires from the mast's top, to assist in sustaining your person when you place the remaining bolt in its proper hole. When this is done, remove the counterpoise and tighten your permanent guy wires until your mast is perpendicular, or better yet, leaning backward 2 or 3 inches at the top, thus allowing for the weight of the antenna to pull the mast to plumb.

If you have painted this outfit, you will have a mast that will not be a continual eyesore and that can be easily lowered for changing wires for experimental purposes, as well as the pleasure that will be yours for doing a difficult job in an easy way.

Contributed by R. Williams.

HOME-MADE TUNING UNIT

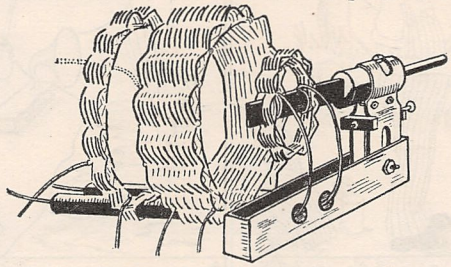
This tuner should meet the needs of experimenters especially, as it makes possible the trying out of various sizes of coils as well as different adjustments in relation to one another. The primary and secondary coils may be placed either on the right or left of the tickler, or one may be placed on each side of it by an easy change of the position of the tubes in the frame.

The plate coil is carried on a shaft made of wood, preferably straight grained walnut—the blade, bearing surface and dial shaft all in one piece. To make it moisture-proof and extremely surface-hard, it should be coated with a solution made by dissolving a piece of phonograph record in alcohol. The leads of the plate coil are taken from opposite sides, given a couple of loose turns around the shaft, as shown, and then run directly through the tubes to their respective binding posts in the set. This coil should be of No. 24 or 26 wire.

The upright and horizontal pieces are made from two strips of medium weight aluminum. The tubes may be ¼-inch bakelite or rubber, or may be made at home by winding several turns of good paper around a nail or wire with a bit of glue on the turns and at the finish. They should be trimmed to length before removing from form, and afterward coated inside and out with the solution mentioned above for the shaft.

In constructing, the tickler shaft should be made first, followed by binding one of the strips at its middle nearly around the shaft, then back somewhat, something after the way shown in the sketch, leaving the two sides parallel. The other piece, or horizontal member, is made by bending the turns at right angles with short right-angle turns at ends to make a face against the back edges of the vertical piece, forming a lock in connection with the bolt in the slots. This bolt has a piece of tubing on its middle—that is, between the slots, and of a length to keep the sides of the pieces parallel and the whole frame rigid when the nut is tightened.

A screw passes through the slot of the bearing and into the shaft to hold the shaft in position and to act as a stop to prevent injury to coil by unnecessary twisting. The two small bolts below adjust the tension on the shaft to suit the uses. A small piece of rubber, or other 3/8-inch panel "scrap," carries a screw or bolt by which the tuner is mounted either to the panel or baseboard at practically any point on either piece of the tuner frame. In panel mounting a piece of fibre board should be used at the back to balance the thickness of turned ends of the piece carrying the tubes. The slots at the bottom of the vertical piece are to allow raising or lowering different diameter coils in relation to the tickler. All the holes and slots should be made after the pieces are



An excellent method of mounting a three-circuit tuner is shown above, there being a minimum of insulation in the apparatus.

formed and trimmed. The strip carrying the antenna and ground posts should be placed in front of the tuner, as is customary, and the leads from the coils carried directly to them. The dotted line shows how the upper secondary lead may go to the condenser.

An article in August Radio News covers the making of coils for this tuner. The number of turns on the coils will, of course, depend on the wave band to be covered and the particular condenser used. Measurements for the various pieces are not given as these can be worked out easily from the sketch to suit the constructor's own ideas.

Contributed by M. A. Richardson.

VARIABLE CONDENSER

For the fan who desires an "up to the minute" receiver that has that "factory look," here's something that will help him get it.

A condenser that does the work costs little, has a perfect vernier, looks like a lot, is a space saver and is very easily constructed. Here's how.

Cut a circle approximately 3 inches in diameter, from flat, dry wood, thick cardboard or bakelite. In its center attach a shaft long enough to go through stator plate and panel and permit of fastening a pointer in front of panel. This is the rotor. One half of the circle is covered with tin or copper foil. The stator is similarly constructed except that it has an extension at the bottom for the vernier. Holes are drilled in their proper locations of such a size as to fit the condenser and vernier shafts snugly. One half of the circle on this plate is also covered with tin or copper foil, except that a small space is left around the hole that the rotor shaft passes through. Now cut from a piece of mica, a disc slightly larger than the diameter of the condenser plates for a dielectric, which goes between the two plates and prevents shorting.

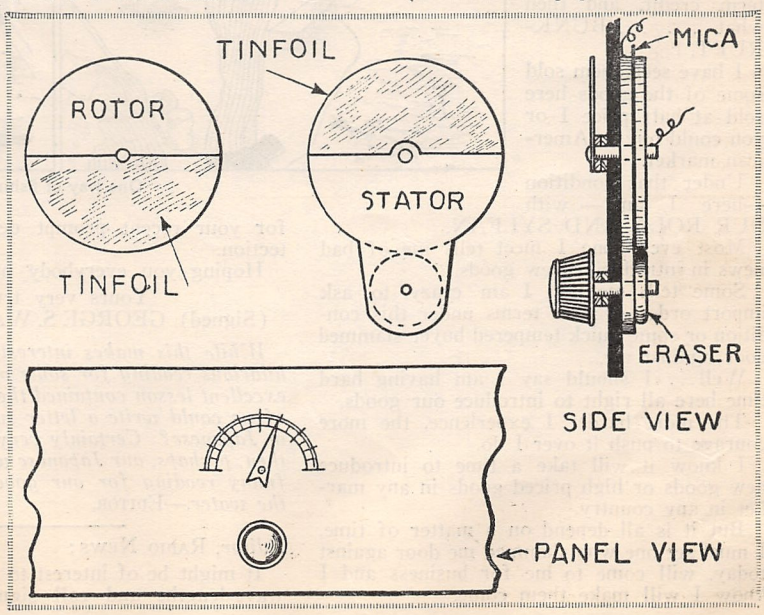
The vernier is made by soldering a suitable shaft to the center hole of a circular typewriter eraser, which is also long enough to pass through stator plate and panel and permit of fastening a knob thereto.

The rotor must be quite round and the hole for the vernier must be so drilled that the eraser will engage the rotor in its revolutions and will not slip.

The panel scale may be scratched on the panel with the aid of a sharp compass and rule and knife, and scratches filled in with white enamel, or a scale may be purchased for a few cents. The stator may be glued or otherwise fastened to the panel and holes drilled in the panel to correspond exactly with holes in the stator.

A pointer may be made from various materials and in various designs, as desired, which may be soldered or otherwise fastened to the rotor shaft. Washers should be placed between pointer and knob, and the panel, so that there will be no play of the two shafts. A study of the diagrams will indicate the condenser's construction. Leads may be attached in various ways. The ro-

(*Continued on page* 1008)



A variable condenser can be easily made by following the directions above and the diagrams on the right. As can be seen by the panel view the appearance of the control from the front will be an asset to the appearance of any receiver.

Correspondence from Readers

In this department the readers air their views on many important questions of the day. Comment is invited and an attempt is made to give equal weight to both sides of a controversy regardless of the magazine's policy.

HOW IT IS DONE IN JAPAN

The following is a letter received not so long ago by a San Francisco radio house from its Japanese representative:

Dear sir:

Upon landing on Japan, I have been lost no time to go in to market and kept myself busy with importers and wholesalers of radio goods, shoeing them our ROLA and SYLFAN.

They have had a very busy time in demand for all kinds of radio goods—good and bad in May and June—these were the result from public fans radio receiving for the first time in their life out here in Osaka and Kobe territory which began receiving from July 1st.

They have supplied them mingled goods of good and bad, they have brought in from America and Europe.

Those importers have had no radio mechanical knowledge to judge what receiving sets were best to handle.

On the other hand, public had no knowledge to select what sets were good.

SO GOD HELPED.

THEY DISPOSED GOODS AT PROFIT.

It is natural that they would think they would think themselves that they were right themselves in selecting them.

On and on, they have placed orders and orders without knowing what it would happen today on bad sets or the radio summer slack.

Orders begin to come in, troubles on sets sold began to come back on them, summer slack nocked at their door.

NOW WHAT HAPPEN.

Dumping. dumping, consignment, long term credit, and then what . . . . BUNKRUPT.

I have seen them sold some of the goods here sold at half price I or you could buy in American market.

Under that condition —here I am — with OUR ROLA AND SYLFAN.

Most every one I meet tells me of bad news in introducing new goods.

Some tells me that I am crazy to ask import order or cash terms under this condition or some quick tempered buyer slammed door against me.

Well... I should say I am having hard time here all right to introduce our goods.

The more harder I experience, the more courage to push it over I do.

I know it will take a time to introduce new goods or high priced goods in any market in any country.

But it is all depend on a matter of time, I must see one who slammed me door against today, will come to me for business and I know I will make them come.

By the way I wish to inform you that your Seattle agent is trying to bother me in this market.

I have seen their letter in one the importer friend of mine.

May I ask you your cooperation and to have you write this agent in Seattle to heep hands off export for Japan.

Day before yesterday, I entertained some twenty people in one of the most fashionable restaurant and introduced Rola while local broadcasting were going on, cost me Yen 250.00 I put ad in a magazine cost me Yen 150.00 per month for six month.

Spending———no. I am investing—That is all.

It would be a wisest investment only when I am protected in fullest extent for Japan Export.

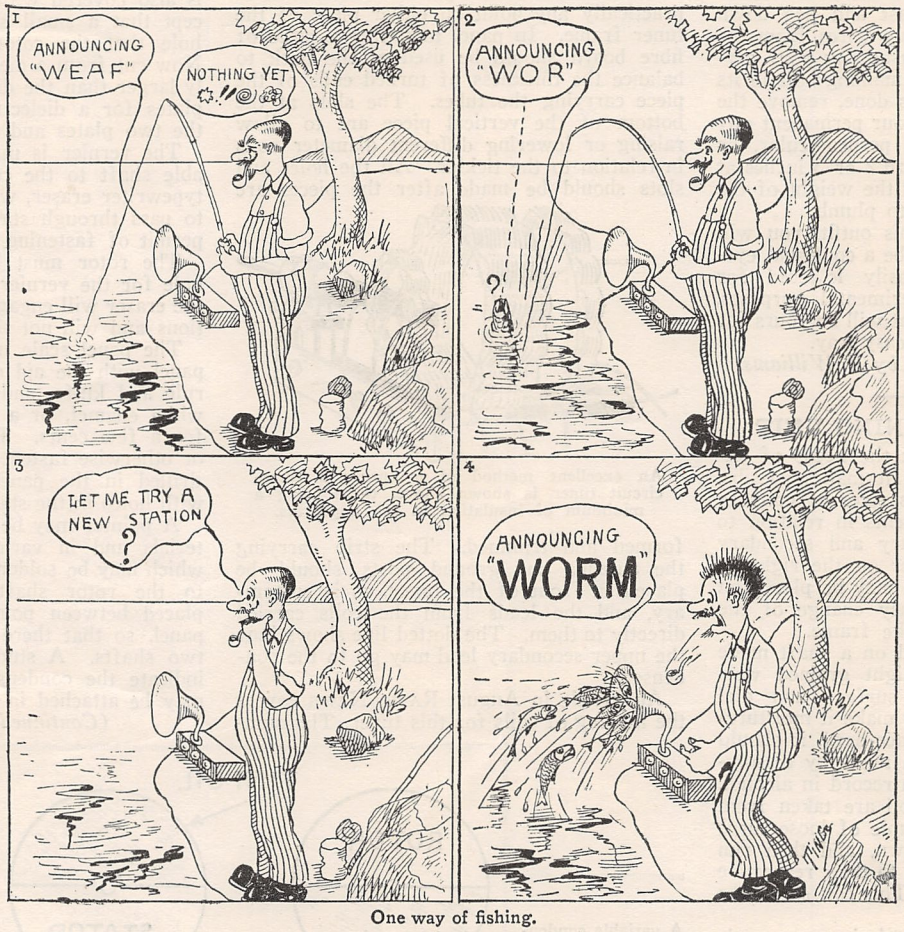
In closing this letter, I wish to thank you for your recent prompt delivery and protection.

Hoping you everybody happy, I am

Yours very truly

(Signed) GEORGE S. WANTANABE.

While this makes interesting and perhaps hilarious reading for some of us, there is an excellent lesson contained therein. How many of us could write a letter such as the above in Japanese? Certainly very few could, and then, perhaps, our Japanese would make some funny reading for our good friends across the water.—EDITOR.



One way of fishing.

Editor, RADIO NEWS:

It might be of interest to you to have the wave-lengths and call signs of the three South African broadcast stations. These are located at Capetown, Johannesburg and Durban, respectively, details of which are as follows:

Capetown—Wave-lengths, 375 meters. Call sign, "Capetown calling." Marconi 6 kw. transmitter.

This station is run by the Cape Peninsula Broadcasting Association, Ltd., 142 Longmarket Street, Capetown.

Johannesburg—Wave-length, 438 meters. Call sign, "JB." Western Electric Transmitter operating with 500 watts in the aerial.

This station is run by the Associated Scientific and Technical Broadcasting Company, Ltd., P. O. Box 4559, Johannesburg.

Durban—Wave-length, 400 meters. Call sign, "Durban calling." Marconi 6 kw. transmitter.

This station is run by the Durban Municipality, Town Hall, Durban.

As you are aware, we receive the short-wave stations with the greatest ease, and KDKA is as well known in South Africa as our own stations.

G. V. ADENDORFF,
Ed. *Capetown Calling.*

NEAR EAST SPEAKS

Editor, RADIO NEWS:

What is happening about radio among Syria, Palestine and the Near East, whose peoples should show an interest, I should believe, like everyone else? Can someone give me a little information?

Friends who work in the laboratories of a telephone company have said that there are "amateur low-wave stations" in the Near East. Could my friends in the homeland hear these perhaps, do you think?

DONJAIN KILDIKJIAN,
New York City.

MERCURY AS A CRYSTAL DETECTOR

Editor, RADIO NEWS:

The enclosed manuscript, a translation by myself from *Chemiker-Zeitung,* gives all the information so far available on a rather peculiar discovery, which I think may be of interest to readers of your columns.

JULIAN F. SMITH.

It is a familiar fact that crystal detectors now in use include galena, zincite with a crystal face from a piece of telluriam as counter contact, pyrite with fine gold wire as counter contact, carborundum, silicon and others. This subject is covered by Dr. Ferdinand Nikolai under the title, "Detector Crystals and Their Treatment," in the Technical Review section of the Graz *Tagespost* of August 9, 1925.

I have discovered by chance that mercury also has the property of acting like

(*Continued on page* 1093)

STANDARD HOOK-UPS

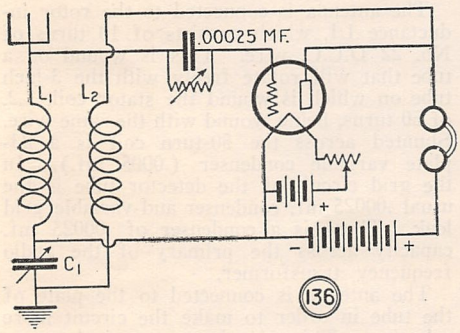
EVERY month we present here standard hook-ups which the Editors have tried out and which are known to give excellent results. This leaf has perforation marks on the left-hand margin and can be cut from the magazine and kept for further reference. These sheets can also be procured from us at the cost of 5c per sheet to pay for mailing charges.

RADIO NEWS has also prepared a handsome heavy cardboard binder into which these sheets may be fastened. This binder will be sent to any address, prepaid on receipt of 20c. In time there will be enough sheets to make a good-sized volume containing all important hook-ups. Every year an alphabetical index will be published enumerating and classifying the various hook-ups.

Handy Reference Data for the Experimenter

A ONE-CONTROL REGENERATIVE RECEIVER

Circuit No. 136. The circuit shown in Fig. 136 should be one of the world's best if it does half the things its originator claims for it. However, there is but one tuning control, the condenser, C1, that has a capacity of .001 mf. (43 plates). However, in sets of this character the adjustment of the filament rheostat is an important matter, but once set this adjustment may remain constant for a considerable period.



In the circuit shown above, no control of the coupling between coils L_1 and L_2 is needed. The condenser C_1 simultaneously controls both tuning and regeneration.

The inductances, L1 and L2, are honeycomb coils each having the same number of turns, 100. They are clamped together as tightly as possible, as variable coupling in this set is unnecessary. The regeneration is capacitatively controlled by the 43-plate condenser, which automatically controls the tuning at the same time. The tube to use in this circuit for good results may be the UV201-A or the C301-A type, with from 22½ to 45 volts on the plate battery. Of course, it is hardly necessary to say that the only antenna on which this circuit will operate successfully is one that is outdoors. This set may be mounted on a panel that is about 10 inches in length and so may be made into a portable outfit.

SUPER-REGENERATIVE CIRCUIT

Circuit No. 137. One of the most interesting circuits with which the man who builds his own set can experiment is the super-regenerative. No other circuit, with the possible exception of the reflex, holds such possibilities for volume for a given number of tubes. The unique feature of the hook-up shown in Fig. 137 is the control of regeneration, which is done by the Reinartz method.

The inductances L1 and L2 are wound on the same 3-inch tube. The primary inductance, L1, consists of 15 turns tapped at the 1, 4, 10 and 15th turns and these taps connected to an inductance switch, the movable arm of which is connected to the antenna. The secondary inductance, L2, has 50 turns and is spaced about ¼ inch from the primary coil. The tickler coil has 30 turns and is spaced about the same distance as the primary is from the secondary. Use No. 22 D.C.C. wire for winding these inductances. The inductances, L4 and L5, may be honeycomb coils, having 1,500 and 1,250 turns respectively. The choke coil, L6, consists of 250 turns of No. 22 D.C.C. wire wound on a 2-inch tube. The audio frequency transformer should have a ratio of 3½ to 1.

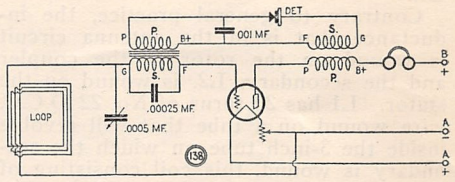
The secondary coil is shunted by a 23-plate condenser (.0005 mf.) and a condenser of the same size is connected between one side of the tickler coil and the common point of the primary and secondary coils. There is also a 23-plate condenser connected across the two honeycomb coils, which are hooked up in series. This condenser is not critical and after once being adjusted may remain untouched.

The variable condensers, C1 and C2, are rather critical in tuning adjustment and it would be well to have vernier attachments or dials on these condensers. It would be well to have a negative grid bias on the amplifier tube of 4½ volts, but if this is not possible connect the grid return lead to the negative side of the "A" battery. The two honeycomb coils, L4 and L5, should be varied in their inductive relationship, as their exact position can be determined only by experiment. UV-201A or C-301A tubes should be used in both cases, having a "B" battery voltage of 90 volts at least.

A ONE-TUBE REFLEX

Circuit No. 138. The circuit shown in Fig. 138 will be found to be one that will gladden the heart of the fan who is looking for a circuit for a portable receiver. The antenna, which is of the loop type, may be built in the lid of the case, or if the set is to be used at home, the usual loop will suffice.

The apparatus for this receiver is easily found around the work-bench. There is required one audio frequency transformer and one radio frequency transformer. The loop antenna should have about 85 or 90 feet of wire wound in the most convenient manner for the constructor. The crystal detector, if the set is to be portable, should be one that has a permanent adjustment, as this will facilitate tuning. The .0005 mf. condenser that is shunted across the loop antenna, should be of the straight-line frequency type, because the loggings of the stations will be spread over a wider range. There should be a .001 mf. condenser shunted across the primary of the audio frequency transformer and a .00025 mf. condenser across the secondary.

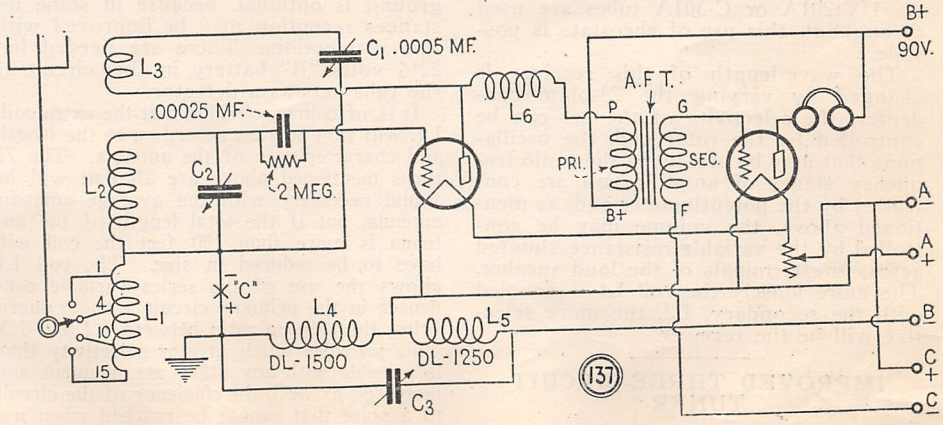


Many experimenters claim that the reflex here shown gives a greater output of undistorted signal than any other single-control one-tube set.

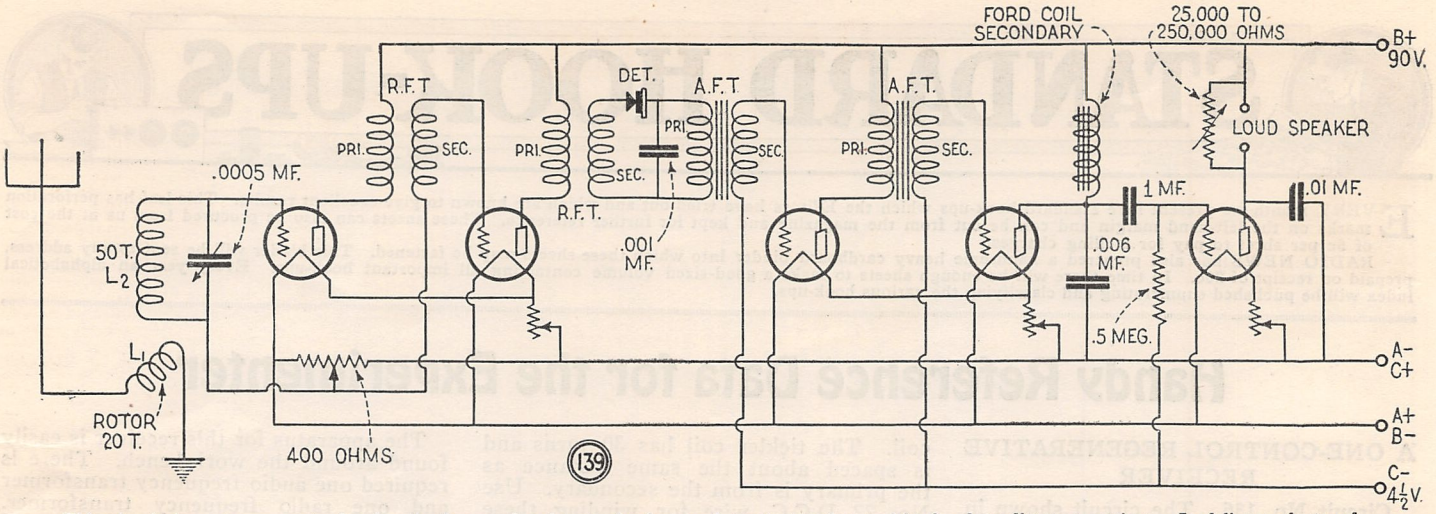
The tuning of this receiver is done entirely with the condenser across the loop. The vacuum tube should be of the UV-201A or C-301A type as it is used in this circuit as an amplifier.

FIVE-TUBE RECEIVER WITH CRYSTAL DETECTOR

Circuit No. 139. By far the quietest and most faithful detector is that with which every good fan and true made his debut, i.e., the crystal. When a crystal detector is combined with vacuum tubes



The super-regenerative circuit here depicted is an interesting variant of Armstrong's original arrangement. The super-regenerator is at present the "dark horse" of radio, and affords by far the richest and least explored field for experimentation



This circuit is a strong contender for the honor of quietest, simplest and most selective multi-tube, long-distance receiver. It delivers plenty of volume as well.

used as an amplifier, as is done in Fig. 139, the result is a receiver that should give excellent reproduction in every detail.

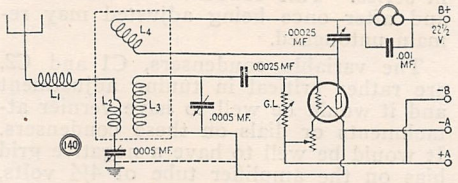
Contrary to general practice, the inductance that is in the antenna circuit is wound on the rotor of the coupler and the secondary, L2, is wound on the stator. L1 has 20 turns of No. 22 D.C.C. wire wound on a tube that will revolve inside the 3-inch tube on which the secondary is wound, this coil consisting of 50 turns of the same size wire. The variable condenser that is shunted across the secondary coil has a capacity of .0005 mf. and should be a straight-line frequency type in order to facilitate tuning. There is a 400-ohm potentiometer connected across the filament battery for obtaining the proper grid bias on the two radio frequency tubes. Across the primary of the first audio frequency transformer there is connected a .001 mf. fixed condenser, one side of which goes to the crystal detector. The last stage of audio frequency amplification is impedance coupled. The coil that is used for this can be the secondary of a Ford coil or a regular iron-core coil having a value from 5 to 10 henrys. There is a variable resistance across the loud speaker terminals the value of which is 25,000 to 200,000 ohms. This resistance is for varying the volume of the output of the receiver. The connections for a "C" battery are indicated, but if the constructor does not wish to avail himself of the advantages of this battery the grid return leads must be connected to the negative "A" battery connections. There are but three rheostats used in the circuit; one in the radio frequency amplifier stages, one in the audio frequency amplifier stages and one in the last stage of audio amplification. As UV-201A or C-301A tubes are used throughout, this use of rheostats is possible.

The wave-length of this receiver is changed by varying the 23-plate condenser, the selectivity of the set can be controlled by the rotor coil, the oscillations that may be present in the radio frequency stages of amplification are controlled by the potentiometer and, as mentioned above, the volume may be controlled by the variable resistance shunted across the terminals of the loud speaker. The more loosely the coil L1 is coupled with the secondary, L2, the more selective will be the receiver.

IMPROVED THREE-CIRCUIT TUNER

Circuit No. 140. Ask almost any dyed-in-the-wool radio experimenter his opinion of the three-circuit tuner and the chances are pretty good that he will concede it to be a real stand-by and friend in time of need. However, there is an improvement that any fan can add to his three-circuit tuner that will greatly increase the selectivity.

The improvement mentioned above is the inductance, L1. The number of turns on this coil must be determined by the builder, but will be about 75. Use No. 22 D.C.C. wire in winding this coil. The



The addition of a single coil, L_1, affords a great improvement in sensitivity and selectivity in the popular three-circuit tuner.

other three inductances, L2, L3 and L4, can be prepared as in any three-circuit tuner. Coils L2 and L3 are wound on a 3-inch tube and L4 is wound on a tube that will revolve within the other. L2 has 10 turns, L3 has 50 turns and the tickler L4 has 30 turns, all coils being wound with No. 22 D.C.C. wire. There is shunted across the secondary coil a 23-plate (.0005 mf.) variable condenser and across the tickler coil a variable condenser, having a capacity of .00025 mf. In series with coils L1 and L2 there is another 23-plate condenser.

The coils of the three-circuit tuner should not be in inductive relationship with the coil L1. The heavy dotted line from negative side of the "A" battery to ground is optional, because in some instances reception may be improved with this connection. There are needed but 22½ volts "B" battery in this circuit as the tube acts as a detector.

It is, of course, obvious that the extra coil, L1, will vary in size, according to the length and characteristics of the antenna. The 75 turns mentioned above are all that will be found necessary with the average amateur antenna, but if the total length of the antenna is more than 150 feet the coil will have to be reduced in size. The coil L1 allows the use of the series variable condenser in the primary circuit without sacrificing the step-up ratio between L2 and L3. This provides much greater selectivity than is possible with any other arrangement and increases, as well, the efficiency of the circuit to a point that cannot be reached when use is made of the more common aperiodic primary.

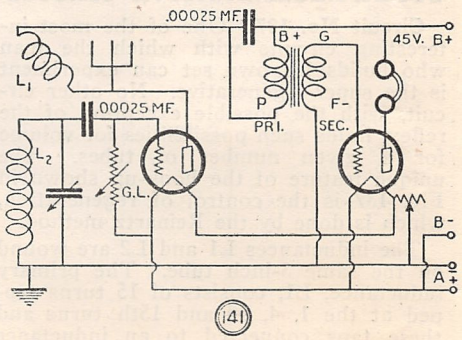
PLATE INPUT CIRCUIT

Circuit No. 141. In Fig. 141 is shown a circuit that is different from the average one with which American fans are familiar. This is an English hook-up and, as there are new characteristics, it should prove of interest to experimenters.

The antenna is connected to the rotor inductance L1, which consists of 10 turns of No. 22 D.C.C. wire. This is wound on a tube that will rotate freely with the 3-inch tube on which is wound the stator coil, L2, of 50 turns, being wound with the same wire. Shunted across the 50-turn coil is a 23-plate variable condenser (.0005 mf.). In the grid circuit of the detector tube is the usual .00025 mf. condenser and variable grid leak. There is a condenser of .00025 mf. capacity across the primary of the audio frequency transformer.

The antenna is connected to the plate of the tube in order to make the circuit more selective. This circuit must not be confused with the ultra-audion circuit, as in that circuit the grid of the tube is used in the usual manner. In this circuit the radio frequency input of the tube will vary as the coupling between the two coils is varied, a variable regenerative effect being simultaneously obtained.

Like almost all other circuits that depart from normal hook-ups in some particular feature, this one is best suited for use under certain special conditions. It is especially useful in congested districts, where a great number of antennae are crowded close together, and where powerful local stations form a barrage that makes it impossible for the ordinary receiver to get long-distance signals. Under very severe conditions it is sometimes advisable to remove the ground connection shown in the illustration and to make use of the antenna merely as a unilateral collector of radio impulses, instead of making it a part of a tuned circuit, as is usually the case.



A popular British hook-up in which increased selectivity is obtained by coupling the antenna circuit through the tickler coil.

—Radiotics—

OPEN SEASON FOR INPUTS

In the August issue of the *Great Western Magazine*, Chicago, Ill., there is the following: "The 'Input' is also HUNTED with a .002 micadon fixed condenser." I suppose that the hunter carefully stalks the poor little input and, when within charging distance, shocks it to death. Ain't life tough?

Contributed by John R. Shaw.

THE POOR BENIGHTED 'EATHEN

The *Pittsburgh* (Pa.) *Sun* on August 14 'ad a column of radio hinformation 'eaded "The INDOO Antenna." Hi sye, old thing, didya see in the pipers where the bloomin' eathen 'ad an antenner nimed arfter 'em? Blimmey, is zat so? Why did they? Hi suppose the antennae puts hin the missin' haiches.

Contributed by Ed T. Weismann.

OLD POP TIME ON THE JOB?

The following advertisement appeared on October 23 in the *Evansville* (Ind.) *Journal*: "Receiving set complete with HOUR tubes and batteries." Just what do these tubes do? Do they perk pretty for 60 minutes and then pipe down? Maybe they are for the small boy who has to be in bed early.

Contributed by Mrs. C. R. Schutz.

DO THEY NAME 'EM TOO?

On October 24 the *Washington* (D. C.) *Herald Broadcast* had an advertisement for "R. C. 43 PET condensers." Well, we've bought condensers in drug stores, shoe shine parlors and many other places, but we have yet to go to a pet store to get them. Hurry up, there are only 43 left.

Contributed by Wm. Weigel.

DOES HE PLAY FULLBACK?

The *Literary Digest* of September 26 in an article on condensers remarks that they make efficient "antenna BOOTERS." Just why this is a virtue in condensers we don't know. We should think condensers with so much "kick" would cause squeals and howls throughout the receiver.

Contributed by R. D. Olsen.

ARE THE ANGELS TO BLAME?

In the Randolph Radio Corporation catalog there is the following explanation of fading: "This is a natural phenomenon due to the shifting of the HEAVENSIDE layer." And here we've been blaming the inhabitants of the nether region for all the troubles we've had.

Contributed by S. K. Golding.

LIKE THE WELL-KNOWN GAUL?

The *Evening Public Ledger* of Philadelphia, Pa., on September 26 gave the following valuable information "—stand coil 5 on its end like a loop DYING on its side." What we want to know is just what battles the loop referred to had been through to get in a condition like that.

Contributed by Wm. B. Gibson.

BOY, PAGE MR. WEBSTER

The *Washington* (D. C.) *Herald Broadcast* of October 17 is to be congratulated on fully recognizing the difficulties of assembling *some* types of R.F. amplifiers. They have this gem: "radio frequency COMPLIFICATION." That is sure a "grand and glorious" combination for some radio set assembles that we have seen.

Contributed by G. T. Craig.

DR. JEKYLL AND MR. HYDE?

The *Montreal* (Canada) *Daily Star* for September 26 runs a description of a most unusual neutrodyne which has, among other things, "2 SHAPES of low frequency amplification." We've heard a lot about dual personalities before, but never in sets. But, anyway, we bet there's a *nice* dual when both the shapes start amplifying at once.

Contributed by C. Bush.

BONES OR SUGAR?

In the September issue of *Radio Review* is the following information: "The six CUBES consume only about 9 milliamps in the plate circuit." We suppose that south of Mason and Dixons Line, where is the native lair of the galloping dominoes, they must do *something* to increase radio sellers.

Contributed by Emerson Orser.

IF you happen to see any humorous misprints in the press we shall be glad to have you clip them out and send to us. No RADIOTIC will be accepted unless the printed original giving the name of the newspaper or magazine is submitted. We will pay $1.00 for each RADIOTIC accepted and printed here. A few humorous lines from each correspondent should accompany each RADIOTIC. The most humorous ones will be printed. Address all RADIOTICS to

Editor RADIOTIC DEPARTMENT,
c/o Radio News.

SORTA MUSSED UP

The *Kansas City Star* (Mo.) for October 18, in speaking of a program, said: "The program Wednesday will be covered with ADHESIVE TAPE, SPAGHETTI and ASSISTING SOLOISTS." We hate to receive a program like this on our new loud speaker and think what it would do to the "innards" of the receiver.

Contributed by George N. Wood.

WHO WANTS THE JOB?

On September 27 the *St. Louis* (Mo.) *Post Dispatch* carried an advertisement of radio tubes: "All tubes PATCHED without charge." This must be one of the new steps forward in scientific circles that we've heard so much of. But who knows what they patch with?

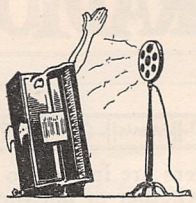
Contributed by Virgil Bratton.

HOT STUFF

In the November issue of *QST* magazine, Hartford, Conn., they tell us that "the coil was TORRID." We carefully perused the entire article but could find no reference to a cooling system to carry away some of the heat waves generated by this coil.

Contributed by David Pierce.

WILL YOUR PIANO DO THIS?



In the *Hartford* (Conn.) *Courant* of October 30 in the column "Heard Last Night On the Air" was this gem: "Christine Metcalfe, PRAYING from WBZ, provided excellent entertainment for those people who like piano compositions." We have known musicians who could "make the piano talk," but evidently Billy Sunday's influence has been felt up in Massachusetts.

Contributed by R. W. Merrill.

WATTA WAVE!

QST magazine, of Hartford, Conn., in the October issue, tells that "9PJ is still 1501200 meters but gets good DX and traffic on these waves." Believe me, boys, you've got to be pretty good to play around waves of this length. Think of the size of the inductances —'scuse us.

Contributed by Dean Spencer.

ONLY TALL BOYS NEED APPLY

The *Dallas* (Tex.) *Morning News* of October 20 had the following employment advertisement: "WANTED — SIX FEET LIVE WIRE for house-to-house work, season just starting. Apply in person." We don't know what the article is to be peddled, but we trust that the lady of the house won't be too shocked.

Contributed by Herbert Tonn.

ALSO TOOT-TOOT

In the November issue of *Radio Age* magazine we have the following: "The primary of the R.F. transformer—through which the PUT-PUT of the tube (T1) is coupled to the following detector tube." What on earth can a "put-put" do on a transformer? We should think it would be bad enough to have the only one in the family installed in the motor boat. But some people are gluttons for punishment.

Contributed by D. R. Bishop.

WHODA THOUGHT IT?

Latest scientific information from the eminent *Bridgeport Telegram* of November 4: "When the voltage of a 5-volt battery gets below 36 volts it begins to cause trouble." We are now dickering for three or four dry cells to use instead of the rather costly "B" batteries on the family blooper, but we'll have to wait till they run down—tough, ain't it?

Contributed by M. Rudland.

AND STILL THEY COME

The *Radio World* of September 19 announced a new publication in the following manner: "I picked up a copy of RADIO-SHRDLUETAOIN-UPNN." Heaven help the poor news butcher who tries to call out that jawbreaker.

Contributed by R. A. Paisley.

WHAT NEXT?

And this from a catalog of the Radio Corporation of America: "A famous star singing to the "unseen audience from radio RECEIVING station." Omigosh, now that that secret has been let loose, we suppose that everyone will think they are broadcasters just there is a receiv family.

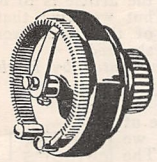
Contributed by J. B

RADIO manufacturers are invited to send to RADIO NEWS LABORATORIES, samples of their products for test. It does not matter whether or not they advertise in RADIO NEWS, the RADIO NEWS LABORATORIES being an independent organization, with the improvement of radio apparatus as its aim. If, after being tested, the instruments submitted prove to be built according to modern radio engineering practice, they will each be awarded a certificate of merit, and a "write-up" such as those given below will appear in this department of RADIO NEWS. If the apparatus does not pass the Laboratory tests, it will be returned to the manufacturers with suggestions for improvements. No "write-ups" sent by manufacturers are published on these pages, and only apparatus which has been tested by the Laboratories and found to be of good mechanical and electrical construction is described. Inasmuch as the service of the RADIO NEWS LABORATORIES is free to all manufacturers whether they are advertisers or not, it is necessary that all goods to be tested be forwarded prepaid, otherwise they cannot be accepted by the Laboratories. Apparatus ready for the market or already on the market will be tested for manufacturers, as heretofore, free of charge. Apparatus in process of development will be tested at a charge of $2.00 per hour required to do the work. The Laboratories will be glad to furnish readers with technical information available on all material listed here on receipt of a stamped envelope. The Laboratories can furnish resistances of the various instruments, amplification curves of transformers, losses in condensers, etc., and other technical information. Address all communications and all parcels to RADIO NEWS LABORATORIES, 53 Park Place, New York City.

Apparatus Awarded Certificates

TURK RHEOSTAT

The rheostat shown in the illustration was submitted to the RADIO NEWS LABORATORIES for test by George Turk, 30 Irving Place, New York City. This rheostat has a rate



of resistance of six ohms and operates satisfactorily as a filament control in radio receivers.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 944.

GRID LEAK MOUNTING

This grid leak mounting was submitted to the RADIO NEWS LABORATORIES for test by the Electrad Co., Inc., 428 Broadway, New York City. This mounting furnishes a very rapid means of changing the coup-

ling capacities and resistances in resistance coupled amplifiers.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1013.

AUTOFORMERS

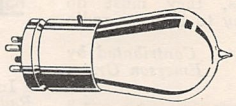
This autoformer, shown in the illustration, was submitted by the Thordarson Electric Mfg. Co., 500 West Huron St., Chicago, Ill. It has a single winding and is used as an

autotransformer. It is used in impedence coupled audio frequency amplifiers and reproduces with good quality and volume under the usual conditions of plate voltage.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1021.

MUSSELMAN CERTIFIED TUBE

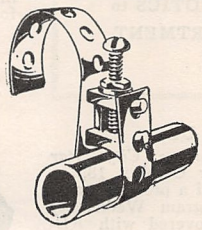
The tube shown in the illustration was submitted by the Van Horne Company, of Franklin, Ohio, to the RADIO NEWS LABORATORIES for test. This tube is unique and interesting in respect to the individual characteristic curve which is supplied in each box with the tube. Each tube is tested individually and its individual characteristic curve sketched and drawn in red ink on the chart. The tube is very well made and has favorable characteristics, operating satisfactorily as an audio and radio frequency amplifier and also as detector.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 875.

"NASCO" GROUND CLAMP

This ground clamp was submitted to the RADIO NEWS LABORATORIES for test by the Moore Products Co., 1608 S. Burlington Ave., Los Angeles, Calif. It affords an easy



method of obtaining a good permanent ground on water pipes, etc.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 905.

LIGHTNING ARRESTER

The lightning arrester shown in the illustration was submitted to the RADIO NEWS LABORATORIES for test by the Kirkman Engineering Corp., 484 Broome St., New York City.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 945.

WARD LEONARD RESISTOR

This resistor, shown in the illustration, was submitted to the RADIO NEWS LABORATORIES for test by the Ward Leonard Electric Co., Mt. Ver-

non, N. Y. It is sturdily built and can stand high temperature without deterioration or appreciable change of resistance.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 947.

FEATHERWEIGHT PHONES

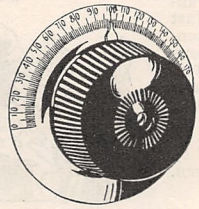
These Featherweight Phones were submitted by the Spartan Electric

Corp., 99 Chambers St., New York City. They are very light in weight and very sensitive.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 901.

VERNIER DIAL

This dial was submitted by the Walbert Mfg. Co., 925 Wrightwood

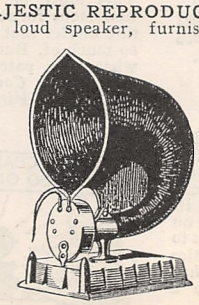


Avenue, Chicago, Ill., to the RADIO NEWS LABORATORIES for test. It is well made and easily mounted and furnishes an easy method for obtaining vernier action in the condenser.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 989.

MAJESTIC REPRODUCER

This loud speaker, furnished by



the Grigsby-Gruno-Hinds Co., 4540 Armitage Avenue, Chicago, Ill., affords very good reproduction of radio concerts without disturbing distortion and with sufficient volume for all ordinary purposes. Two models were submitted, the Home Concert model and the Baby Grand model.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATES OF MERIT NOS. 872 AND 873.

TIP CONNECTOR

The tip connector shown in the illustration was submitted to the RADIO NEWS LABORATORIES for test by the C. H. Overman Co., 124 E. Fourth St., Marion, Ind. This connector is convenient for quickly connecting several sets of head-phones in series. It may also be used for

other apparatus where quick temporary connections are required.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1035.

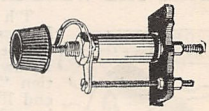
HACK-SAW BLADE

The blade shown in the illustration was furnished by the Alpha Electric Co., 131 West 30th Street, New York City, and submitted to the RADIO NEWS LABORATORIES for test.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 930.

ELECTRAD VARIOHM

The instrument shown in the illustration was submitted to the RADIO NEWS LABORATORIES for test by the Electrad Co., Inc., 428 Broadway, New York City. This variohm is a high resistance for connecting the turns of a transformer for reducing the volume or for enabling repro-

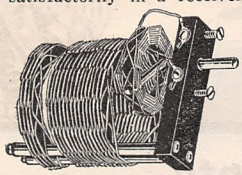


duction to be obtained without considerable distortion or amplifier noises.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1038.

COAST COUPLER COILS

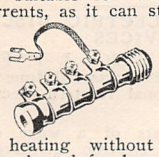
The coil shown in the illustration was submitted to the RADIO NEWS LABORATORIES for test by the Coast Coupler Co., 245 East 7th Street, Long Beach, Calif. These coils are of the low loss type and operate very satisfactorily in a receiver.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1026.

WARD LEONARD VITROHM

This Vitrohm was submitted to the RADIO NEWS LABORATORIES for test by the Ward Leonard Electric Co., Mt. Vernon, N. Y. This is a resistance suitable for working on heavy currents, as it can stand con-

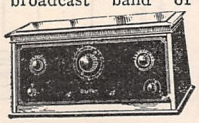


siderable heating without burning out. It is adapted for lamp sockets.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 947.

DAY-FAN RADIO SET

This radio set was constructed by the Dayton Fan & Motor Co., Dayton, Ohio, and was submitted to the RADIO NEWS LABORATORIES for test. It operates satisfactorily over the entire broadcast band of wave-



lengths and reproduces with satisfactory volume and selectivity.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1054.

SOLDERING FLUID

The soldering fluid shown below was submitted to the RADIO NEWS LABORATORIES for test by John Firth, 25 Beaver Street, New York City.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 806.

FORD "B" SUBSTITUTE

The "B" battery shown in the illustration was submitted to the RADIO NEWS LABORATORIES for test by the Ford Mica Company, 14 Christopher Street, New York City.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1004.

SPRING-GRIP BINDING POST

The binding post, manufactured by Frank Morse Mfg. Co., 286 Congress Street, Boston, Mass., was submitted to the RADIO NEWS

LABORATORIES for test. This binding post is unique in the fact that no screw motion is required for fastening a nut. All that is necessary is to press a nut against the spring so that the wires are always held in firm contact.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 999.

DETECTOR TIP

This detector, shown in the illustration, was submitted to the RADIO

NEWS LABORATORIES for test by V. L. Chamberlin, Pontiac, Mich.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1008.

RADIO CRYSTAL

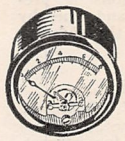
The radio crystal shown in the illustration was submitted to the RA-

DIO NEWS LABORATORIES for test by the T. N. T. Products, 1344 Fillmore Street, San Francisco, Calif.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1036.

VOLTMETER

The voltmeter illustrated above was submitted to the RADIO NEWS LABORATORIES for test by the Jewell Electrical Instrument Co., 1640 Wal-

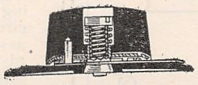


nut St., Chicago, Ill. It is a very accurate voltmeter and can be used very satisfactorily for measuring low voltages, such as those of storage batteries.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1003.

BRANSTON DIAL

The dial shown in the illustration was submitted to the RADIO NEWS

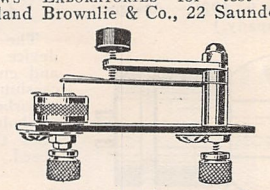


LABORATORIES for test by the Charles A. Branston, Inc., 815 Main Street, Buffalo, N. Y. It is a vernier dial of the gear type. It works satisfactorily in a radio receiver without any appreciable back lash.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 868.

BROWNLIE DETECTOR

The detector shown in the illustration was submitted to the RADIO NEWS LABORATORIES for test by Roland Brownlie & Co., 22 Saunders



Street, Medford, Mass. It is designed for panel mounting. A very fine, accurate adjustment of a crystal contact can be obtained with this detector.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1017.

FOLDING LOOP

This loop was submitted to the RADIO NEWS LABORATORIES for test

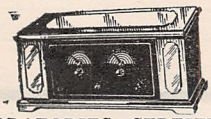
by the Aalco Radio Laboratories, Inc., 6336 Cottage Grove Ave., Chicago, Ill. This loop is collapsible and well made. It will cover the broadcast band of wave-lengths with a .0005 mfd. condenser.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1032.

DAVID GRIMES RECEIVER

The set illustrated above was submitted to the RADIO NEWS LABORATORIES for test by David Grimes, Inc., 151 Bay Street, Jersey City, N. J. This set operates satisfactorily over the entire broadcast band of wave-lengths and reproduces with satisfactory volume and selectivity.

AWARDED THE RADIO NEWS



LABORATORIES CERTIFICATE OF MERIT NO. 1052.

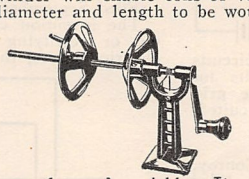
LOW-WAVE COIL

The low-wave coil shown in the illustration was submitted to the RADIO NEWS LABORATORIES for test by the Ambassador Sales Co., Inc., 108 Greenwich Street, N. Y. C. This coil is of the low loss type and operates very satisfactorily in a receiver.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1027.

COIL-WINDER

The coil-winder illustrated above was submitted to the RADIO NEWS LABORATORIES for test by the Goodell-Pratt Co., Greenfield, Mass. This coil-winder will enable coils of varying diameter and length to be wound



very neatly and quickly. It will wind only cylindrical coils.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1012.

SCREW GRIPCORD TIPS

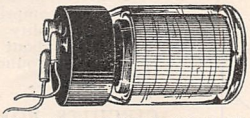
The cord tips shown in the illustration were submitted to the RADIO NEWS LABORATORIES for test by the Barkelew Electric Mfg. Co., Middletown, Ohio. The wire is inserted into a hole and a wooden screw driven into the stranded end of the

wire. This holds the wire very rigidly in the connector. The parts are then screwed together and form a perfect electric point.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1006.

WONDER CELL

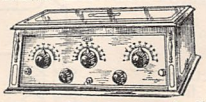
The Wonder cell submitted by the RADIO NEWS LABORATORIES for test by the Helios Battery Co., 71 Chestnut Street, Boston, Mass., is furnished for use with radio receivers for supplying the filament lighting current. It can be charged many times without deteriorating.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1055.

ERLA RECEIVING SET

The receiving set shown in the illustration was submitted to the RADIO NEWS LABORATORIES for test

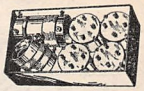


by the Electrical Research Laboratories, 2500 Cottage Grove Ave., Chicago, Ill. It operates satisfactorily over the entire broadcast band of wave-lengths and reproduces with satisfactory volume and selectivity.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1053.

KIT

This super-heterodyne kit was submitted to the RADIO NEWS LABORA-

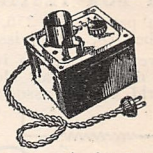


TORIES for test by William Rosenbloom, 11 Deering Road, Mattapan, Mass. Oscillator and antenna coils are furnished together with four intermediate transformers.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 994.

TUBE REVIVER

The instrument shown in the il-



lustration was submitted to the RADIO NEWS LABORATORIES for test by the Remo Corp., Meriden, Conn.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1007.

CHAPMEN CRYSTAL

The Supernatural radio crystal shown in the illustration was submitted to the RADIO NEWS LABORA-

TORIES for test by the Chapman Radio Co., 935 Phelon Bldg., San Francisco, Calif.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1011.

COAST COUPLER COIL

The coil illustrated above was submitted to the RADIO NEWS LAB-

ORATORIES for test by the Coast Coupler Co., 245 East 7th Street, Long Beach, Calif. This coil has a primary and secondary winding and operates very satisfactorily as a coupling transformer in radio frequency amplifiers.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1026.

TUBE REJUVENATOR

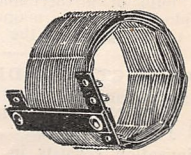
The instrument shown in the illustration was submitted to the RA-

DIO NEWS LABORATORIES for test by the Jefferson Electric Mfg. Co., 501 S. Green Street, Chicago, Ill.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1014.

RADIO FREQUENCY TRANSFORMER

The transformer shown in the illustration was submitted to the RADIO NEWS LABORATORIES for test by



the Benjamin Electric Mfg. Co., 120 So. Sangamon Streeet, Chicago, Ill. This transformer operates very satisfactorily in a receiver.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1016.

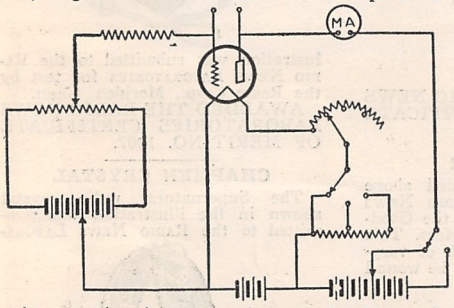
Digest of Latest Canadian Radio Patents

Compiled by G. F. SELLECK, Jr.

CIRCUIT FOR TESTING VACUUM TUBES

(Canadian patent No. 250,502, R. M. Peffer. Filed September 20, 1924; issued June 9, 1925.)

The invention consists in a testing apparatus of the class described, an electron tube, a plate circuit, a grid circuit associated with the plate circ-

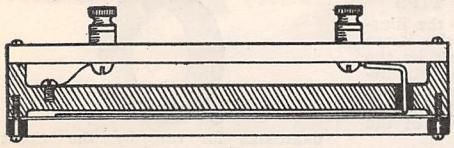


cuit, a testing instrument in one of said circuits and a resistance unit in one of the circuits for protecting the testing instrument should the grid and plate of the electron tube be short-circuited.

MICROPHONES

(Canadian patent No. 250,756, J. M. Conroy, O. G. Mauro and R. A. Scantlebury. Filed April 1, 1924; issued June 16, 1925. Assigned to Marconi Wireless Telegraph Company of Canada, Ltd.)

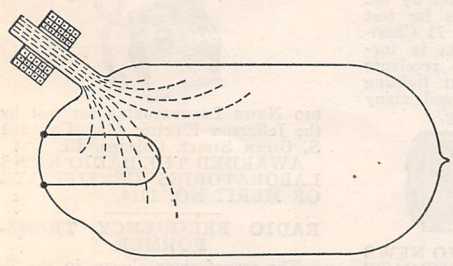
The invention consists in the combination of a diaphragm of elastic material having a natural



period of vibration so low as to be below audibility and supported in such a way as to receive vibrations from an acoustic source, a fluid-tight chamber beneath the diaphragm and electrostatic means for converting the acoustic energy into electrical energy.

MANUFACTURE OF THERMIONIC TUBES AND THE LIKE

(Canadian patent No. 251,273, H. St. J. deA. Donisthorpe. Filed May 9, 1924; issued June 30, 1925. Assigned to Marconi Wireless Telegraph Company of Canada, Ltd.)

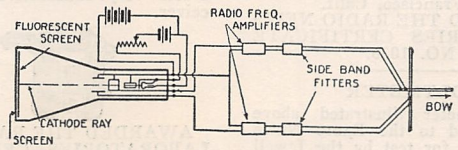


The invention consists in the process of exhausting the bulb of a thermionic valve or the like, the employment of a magnetic field to prevent damage to the glass of the bulb.

RADIO DIRECTION INDICATING SYSTEMS

(Canadian patent No. 251,024. W. A. Steel and A. G. L. McNaughton. Filed September 2, 1924; issued June 30, 1925.)

The invention consists in radio visual direction indicating means comprising goniometer coils fixedly secured at right angles to one another and designed to receive radio signals and means for amplifying the signals and means for applying voltages to deflector plates proportional to the voltages induced in the respective goniometer coils and in corresponding phase displacement thereto, the means consisting in connecting the output circuits to alternate pairs of deflecting plates in a cathode ray tube or to the corresponding coils whereby the relative phase and magnitude of the

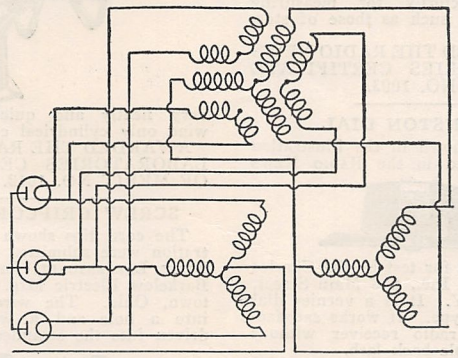


induced voltages in the goniometer coils is preserved unaltered in the output circuits and whereby the relative phase and magnitude of the induced voltages may be adjusted as required.

THERMIONIC DEVICES

(Canadian patent No. 251,167, E. Y. Robinson. Filed September 12, 1923; issued June 30, 1925.)

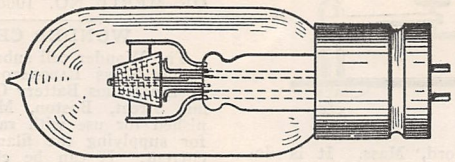
The invention consists in a system for generating or rectifying alternating current by vacuum electric devices, the method of heating the filament



of a vacuum electric device with alternating current which consists in supplying the filament with current which is substantially 90° out of phase with the space current in the device.

MOUNTS FOR ELECTRON DEVICES

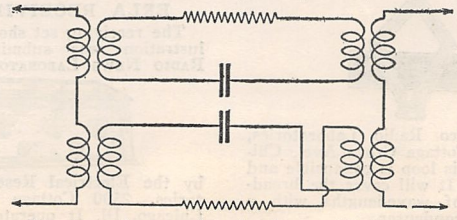
(Canadian patent No. 250,605, P. T. Weeks. Filed March 15, 1924; issued June 9, 1925. Assigned to Westinghouse Lamp Company.)



The invention consists of a mount for an electron device comprising a looped filament, a grid having a plurality of rounded portions concentrically disposed about the filament and a plate having a plurality of rounded portions disposed about said grid.

CIRCUITS FOR ELECTRICAL OSCILLATIONS

(Canadian patent No. 250,485, E. Mayer. Filed April 13, 1922; issued June 9, 1925.)

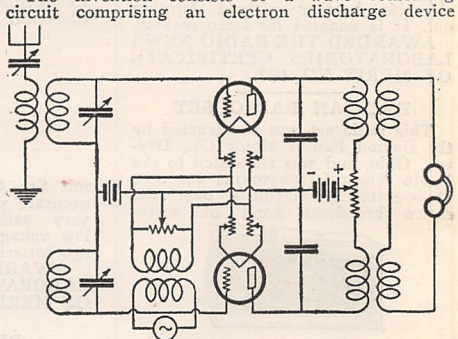


The invention consists in the combination with primary and final oscillatory circuits of two intermediate oscillatory circuits through each of which currents can flow separately from the primary to the final circuit, the intermediate circuits being differently tuned, one as much above the frequency of the primary circuit as the other is below that frequency.

CIRCUITS FOR ELECTRIC DISCHARGE DEVICES

(Canadian patent No. 251,268, J. F. Farrington. Filed December 29, 1923; issued June 30, 1925. Assigned to International Western Electric Company, Inc.)

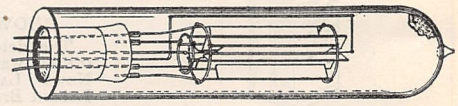
The invention consists of a wave combining circuit comprising an electron discharge device



for producing the combination frequencies of impressed waves, a second electron discharge device, said devices having cathodes, a source of alternating current for heating the cathodes, a utilization circuit for currents of the combination frequencies, associated with said devices, and means for supplying to the utilization circuit currents of the combination frequencies and to balance out from said utilization circuit the variations in the discharge currents of said devices produced by the alternating heating current.

ELECTRON DISCHARGE DEVICE

(Canadian patent No. 251,229, K. H. Kingdon and Irving Langmuir, assignors to Canadian General Electric Company, Ltd. Filed October 30, 1924; issued June 30, 1925.)

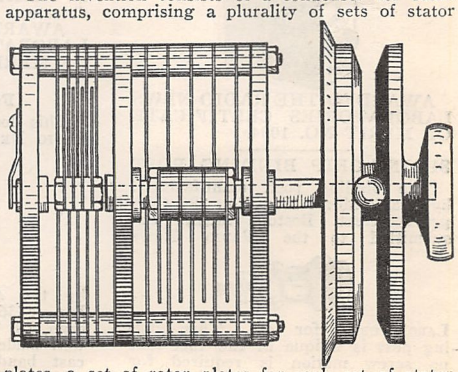


The invention consists of an electron discharge device comprising a cathode adapted to be heated and enclosed in an evacuated receptacle containing caesium, the cathode having formed thereon an absorbed layer of a material having the property of holding caesium atoms more tenaciously than does the material of which the cathode is composed.

CONDENSERS

(Canadian patent No. 251,126, O. G. Lissen. Filed June 4, 1924; issued June 30, 1925.)

The invention consists of a condenser for radio apparatus, comprising a plurality of sets of stator



plates, a set of rotor plates for each set of stator plates, means for independently rotating the rotor plates and means for simultaneously rotating the rotor plates.

Conducted by R. D. Washburne

THIS Department is conducted for the benefit of our Radio Experimenters. We shall be glad to answer here questions for the benefit of all, but we can publish only such matter as is of sufficient interest to all.

1. This Department cannot answer more than three questions for each correspondent. Please make these questions brief.
2. Only one side of the sheet should be written upon; all matter should be typewritten or else written in ink. No attention paid to penciled matter.
3. Sketches, diagrams, etc., must be on separate sheets. This Department does not answer questions by mail free of charge.
4. Our Editors will be glad to answer any letter, at the rate of 25c for each question. If, however, questions entail considerable research work, intricate calculations, patent research, etc., a special charge will be made. Before we answer such questions, correspondents will be informed as to the price charge.

Mr. Washburne answers radio questions from WRNY every Thursday at 8:30 P. M.

THE UNIVERSAL PLIO-6 RECEIVER

(2154) Mr. S. S. Carhart, Elizabeth, N. J., asks:

Q. 1. How can I build the Universal Plio-6 Receiver? The wave-length range of this set is said to be from 30 or 35 meters to about 3,500 meters. Can an amateur successfully build this set, after having assembled several receivers of 3- to 5-tube size and made them all work well?

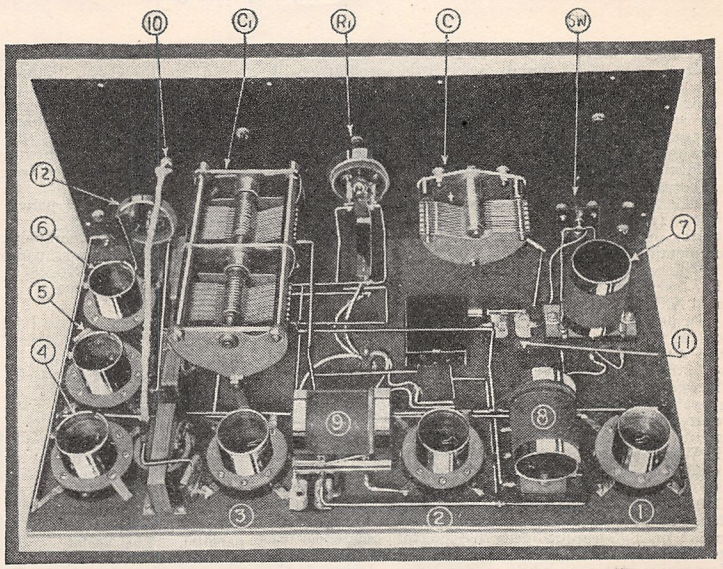
A. 1. The schematic circuit of the receiver mentioned, as well as photographs and construction details, appear in these columns.

The Golden-Leutz receiver described is the first on the American market to have such a wide wave-length range, and yet be designed for high quality reproduction. As will be found stated elsewhere in these columns, receivers are in use for efficient reception of code signals in the 200- to 3,000-meter band, but there has been no occasion to take special "pains" with the audio unit. In fact, it is good engineering to design a code receiver to be highly responsive to a limited frequency scale; anyone having had experience in the reception of C.W. signals will realize that here such a design is quite *la mode*.

There should be no difficulty in constructing this set, if the correct kit is used and the construction blueprints carefully followed. However, one must be rather well along in the "game" to be able to build the receiver successfully from all home-constructed "components," as our English cousins would have it. For example, it may seem a very common-place matter to wind up a few radio frequency transformers to the particular number of turns specified, wire these to the balance of the parts necessary, and consider the receptor completed. Instead, it will be found that the work has only just started, since the placement of the parts, and the constants of every home-constructed unit will vary. However, if commercial apparatus is used, the biggest variable factor is removed and satisfactory operation is assured more quickly.

We are going to avoid considerable repetition and simplify the explanation of this set by making several references to Q. 2151, and the answer, in the I Want to Know department of the December, 1925, issue of RADIO NEWS.

Resistance units "R" are non-inductive resistances of about 750 ohms; whatever is sufficient to prevent circuit oscillation. Perhaps 600 ohms will be sufficient in some sets, depending on the constants of the instruments selected. Tubes and radio frequency transformers, and the placement of the latter, are the most important controlling factors in the values of "R." These resistances are shown in a schematic accompanying the answer referred to in the paragraph above.



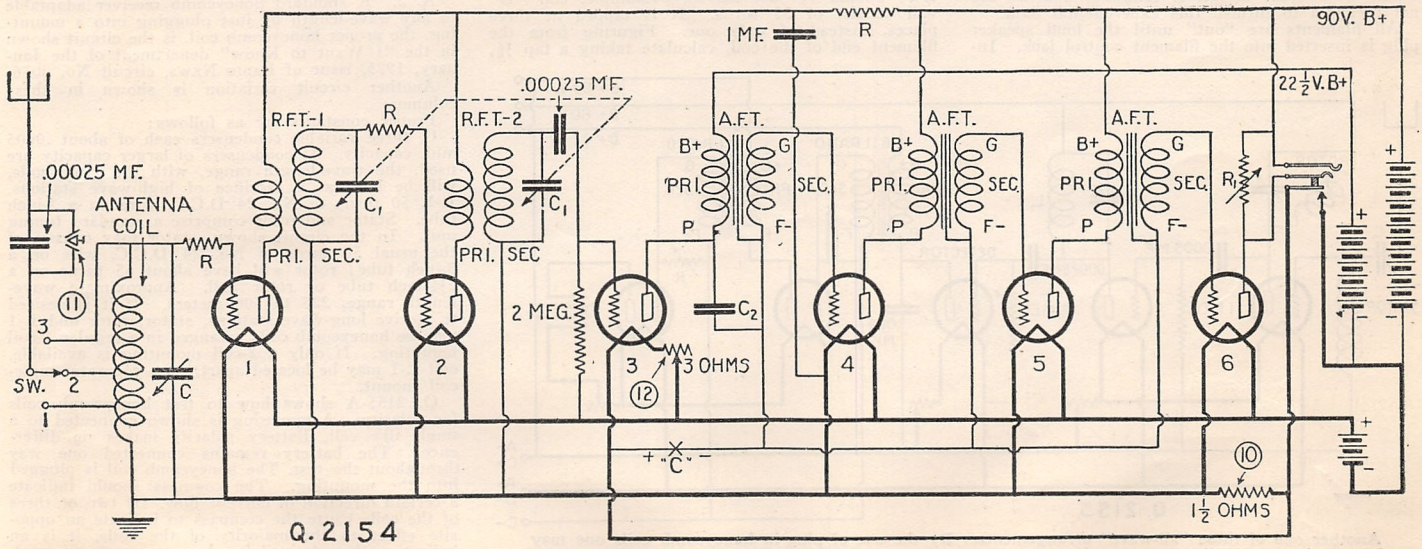
Rear view of a set built in accordance with the schematic circuit shown below as Q. 2154. The inductances are arranged plug-in fashion, No. 7 being "antenna coil" in the schematic diagram; No. 8, "R.F.T.-1"; and No. 9, "R.F.T.-2." 35 meters to 3,500 meters is the wave-length range of Universal Plio-6.

Condenser "C" is of .0005 mfd. capacity; "C-2," .00025 mfd.; the two variable condensers marked "C-1" are each of .0005 mfd. capacity, and constitute what is called a 2-gang variable condenser unit. The fact of the common shaft is indicated by the dotted line. Rotor plates, indicated by the arrowhead, are grounded to the panel.

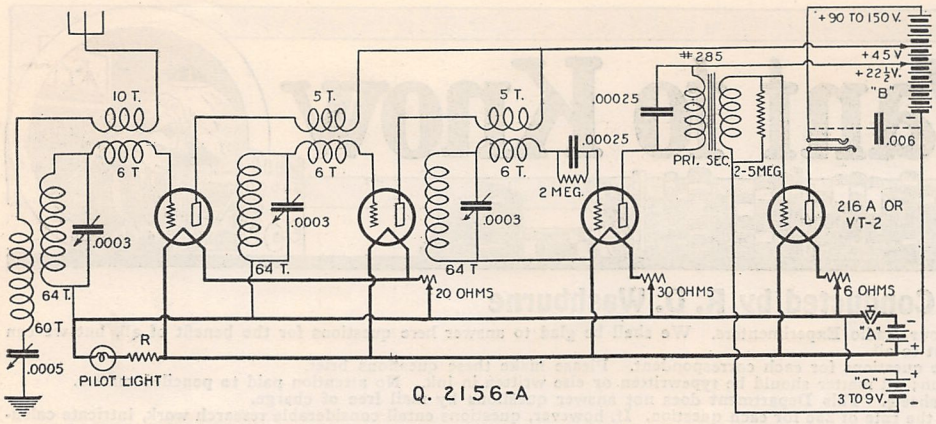
The audio frequency transformers are all of the same ratio, 2:1. If desired, one less stage of audio frequency amplification may be used, and the first audio frequency transformer replaced with a higher-ratio instrument; even a 6:1 ratio transformer may be successfully employed, if care is taken in construction. This matter of two or three stages of audio frequency amplification has been investigated by Golden-Leutz, the co-designers of this receiver, with the result diagrammed. It seems that a two-stage unit having one high- and one low-ratio transformer amplifies to the requisite degree, but "tube noises," that is, loud, "rushing" sounds, result. By adding an additional stage, but reducing the voltage step-up required of each stage, the input signal seems to be amplified to a greater degree than the "action sounds" incident to operation with high-ratio audio frequency transformers. Observe that all the A.F.T. cores are in a line—it is not necessary to place them at right angles. All cores are grounded to "A" minus.

A separate detector "B" battery is recommended and shown in the diagram.

Variable resistance "R-1" shunting the output (the loud speaker, of course) may be a Bradleyohm, or any other good make of variable resistance capable of carrying the heavy plate current resulting without becoming "noisy," having a range of 10,000



Schematic diagram of connection system employed in Universal Plio-6, a receiver designed to cover a wave-length range of 35 to 3,500 meters, by use of the well-known plug-in coil principle. Plugging the loud speaker plug into its jack puts the set into operation automatically, as a "filament control" jack is used.



The Garrison circuit. An unusual arrangement of coils with the object in view of preventing circuit oscillation, and at the same time retaining selectivity and a negative grid bias of the radio frequency tube grids.

to 100,000 ohms. It acts as a volume and quality control. On weak signals, very little resistance will be used; the unit will be operating at its maximum value, 100,000 ohms. By de-tuning ("throwing" the set slightly out of tune by adjusting the tuning circuits slightly off the exact adjustment for a powerful station), varying the 3-ohm detector tube filament rheostat, and resistance "R-1," the output is controlled without sacrificing quality.

The 1½-ohm resistance unit is most non-inductive. It is a 6-inch length of Nichrome wire, asbestos covered, and shows in the photograph as connecting to the panel.

The value of a "C" battery may be determined by insertion in the grid return leads, as shown at "X."

In passing, mention should be made of the design of the variable condenser plates. It is such that the resultant curve is neither straight-line capacity or straight-line wave-length; it is "betwixt and between." The explanation is this: All the higher power stations, those operating with more than 500 watts, have a "Class B" rating. One of the requirements of Class B stations, as pointed out in the I Want to Know department of the September, 1925, issue of Radio News, answering question No. 2141, is that they operate on wave-lengths over 280 meters. If we divide the full broadcast wave-length range in two parts, we may say the general effect of a "straight-line wave-length" condenser is to separate the high-wave stations and crowd the low-wave stations, while a condenser designed to have a "straight-line frequency" calibration may be said to crowd the high-wave stations and separate the low-wave stations. When we consider that there are approximately three times as many stations in the high-wave, Class B, division as there are in the low, and that every one of these Class B stations are employing over 500 watts, the ever-present and vital problem of selectivity is seen, truly, to be a fit one for the most Solomon of Solomons. The variable condensers comprising that part of the kit used in the construction of the receiver shown in the illustrations, are unique in that the plate design is such that the resultant tuning curve is *between* a true straight-line wave-length and a true straight-line frequency curve.

There is no reason why "B" eliminators cannot be used to furnish the plate potentials, if one of the "no hum" variety, of which there are few, is chosen.

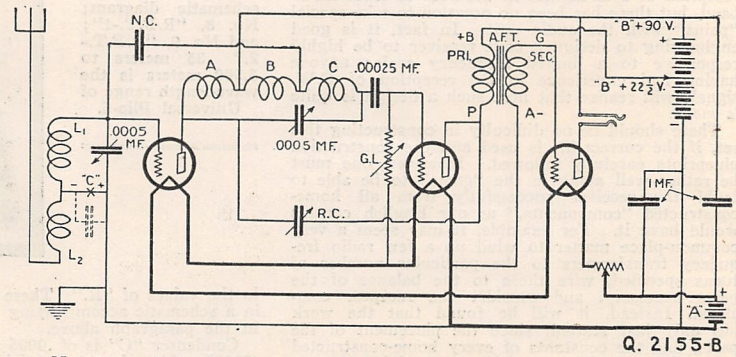
Storage battery tubes are required throughout, unless a different design is followed, and we are not prepared to furnish this experimental data.

All filaments are "out" until the loud speaker plug is inserted into the filament control jack. Instead of this scheme, a Carter jack-switch can be used to light the filaments automatically at the "on" position, in addition to connecting the set to the loud speaker. Since, with this plan, no plug is used, loud speaker connection must be provided for in some manner and you have probably guessed that this is accomplished by providing two binding posts, which posts are wired to the "jack" part of the "jack-switch."

An etched, *metal* panel is recommended by the designers.

A valuable and complete, up-to-date list of long-wave phone stations, compiled from 40 references, appears on page No. 822 of the December, 1925, issue of Radio News.

The Ultra-Selective receiver described in the November, 1925, issue of this magazine, with capacitative control of regeneration added. The new coil values are best for UV-201A type tubes, with filaments in parallel. The aerial circuit may be tuned by means of a variometer.



In the same issue, page No. 876, will be found coil construction details that may be applied to this receiver. More exact data than follow are not available.

In Universal Plio-6, three plug-in units are used to cover a certain frequency (wave-length) band. One, a single coil, is "antenna coil." The remaining are "R.F.T.-1" and "R.F.T.-2." Both have a primary winding and, in lieu of other data, may be made similar to "R.F.T.-1" and "R.F.T.-2" described on page No. 876, mentioned above. "Antenna coil" is, in general, similar to "unit L-1" also therein described. There is an exception to this statement of similarity of coils. It is that the number of turns in the various designs for "unit L-1" should be just halved. Example, coil "D" will consist of 55 turns. It is tapped at three places, instead of only one. Figuring from the filament end of the coil, calculate taking a tap ⅛, ½ and all the way (the grid end) across the coil. Now for R.F.T.-1 and 2. They may have the number of primary turns indicated, but halve the number of secondary turns mentioned. This reduction of turns is necessitated by the fact that the variable condensers used in Plio-6 are of double the capacity the ones in the super-heterodyne (Universal Plio-6, you know, is in the tuned radio frequency class).

The coil design described above calls for four sets of coils. By careful design of the coils, the kit-maker has been enabled to reduce the number of coil sets required to three, to reach 550 meters. Two extra sets are needed to reach the maximum wave-length of 3,600 meters. A suggested design is as follows, for the set of coils required for a wave-length range of 1200 to 3600 meters. "Antenna coil," tapped as described above, may be made by winding a 3½-inch tube with No. 36 D.S.C. wire to a width of 2⅝ inches. The untapped secondaries of R.F.T.-1 and R.F.T.-2 are similarly wound, while the primaries may consist of about one inch of winding of the same size wire, wound over the filament end of the secondary and separated by a single layer of Empire cloth.

The set of shorter range coils for 500 to 1500 meters may be made by double-space winding the same diameter tubing, with the same wire, for a distance of 1¾ inches with the same size wire for "antenna coil"—tapping as described above—and the secondaries of R.F.T.-1 and R.F.T.-2. (Wires may be double-spaced by winding two wires side by side and removing one, after the winding is completed.) The primaries may consist of about one inch of winding, double-spaced, over the filament ends of the coils.

REGENERATION IN THE ULTRA-SELECTIVE RECEIVER

(2155) Mr. Gerald E. Klanderman, Grand Rapids, Mich., asks:

Q. 1. Referring to past articles in the "I Want to Know" department on the subject of long-wave reception, will you list the trade names of American receivers designed to work on wave-lengths over 540 meters?

A. 1. The available list follows:

1—Universal Plio-6 (35 to 3,500 meters). Made by Golden-Leutz, Inc.

2—Kennedy No. 110 Universal (150 to 24,000 meters). Made by Colin B. Kennedy Corporation.

3—Kennedy No. 220 Intermediate (150 to 3,500 meters). Same make as above.

4—R. C. A. Model 1P-501 (500 to 25,000 meters). Made for Radio Corp. of America by Wireless Specialty Apparatus Co.

5—Grebe CR-9 (150 to 3,000 meters). Made by A. H. Grebe & Co. Nos. 2, 3 and 4 require a separate audio amplifier.

Q. 2. Is it possible to use the plug-in coil system in a radio frequency circuit satisfactory for reception of long as well as short waves?

A. 2. A standard honeycomb receiver adaptable to any wave-length by just plugging into a mounting, the proper honeycomb coil, is the circuit shown in the "I Want to Know" department of the January, 1925, issue of Radio News, circuit No. 2076.

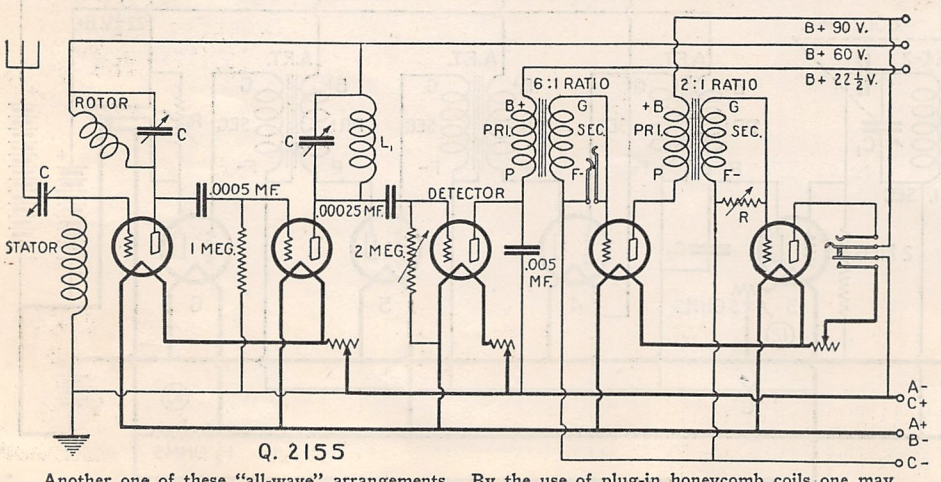
Another circuit variation is shown in these columns.

Proper constants are as follows:

C, three variable condensers each of about .0005 mfd. capacity. If condensers of larger capacity are used, the wave-length range, with the same coils, will be less, at a sacrifice of high-wave stations. L-1, 50 turns of No. 24 D.C.C. wire on a 3-inch tube. Stator and rotor comprise a standard tuning unit. In the circuit shown, stator may consist of the usual 50 turns of No. 24 D.C.C. wire on a 3-inch tube; rotor will have about 65 turns on a 2½-inch tube or rotor ball. Approximate wave-length range, 225 to 600 meters. If it is desired to receive long-wave stations, stator, rotor and L-1 may be honeycomb coils arranged in a regular 3-coil mounting. If only a 2-coil mounting is available, coil L-1 may be located apart, on a separate single-coil mount.

Q. 2155-A shows how to test honeycomb coils for polarity. A mounting is shown connected to a single dry cell. Battery polarity makes no difference. The battery remains connected one way throughout the test. The honeycomb coil is plugged into the mounting. The compass should indicate a certain direction of current flow. If two or three of the coils cause the compass to indicate an opposite effect to the majority of the coils, it is an indication that the coil has been reverse connected.

(*Continued on page* 1060)



Another one of these "all-wave" arrangements. By the use of plug-in honeycomb coils one may have a receiver with a wave-length range of 200 to 30,000 meters. Large tapped coils may be used instead of interchangeable units.

No matter what set you buy, be sure the dealer puts in *genuine* Radiotrons:

UV-199	$2.50
UX-199	$2.50
UX-120	$2.50
UV-201-A	$2.50
UX-201-A	$2.50
UV-200	$2.50
UX-200	$2.50
WD-11	$2.50
WD-12	$2.50
WX-12	$2.50
UX-112	$6.50
UX-210	$9.00

Rectrons:

UX-213	$7.00
UX-216-B	$7.50

A "UX" or "WX" tube is the same as the corresponding "UV" or "WD" tube, except in the design of the base.

for every
Christmas Radio Set
use only genuine RCA Radiotrons

READ all the claims of all the makers of radio sets—and then remember this when you buy—that getting what is claimed for a set depends upon the quality of the *vacuum tube* put into it. You cannot get clearness—you cannot get distance—you cannot get volume—unless the *tubes* get it. That is why it is so important to look at the base of every tube, to be sure it is a *genuine* RCA Radiotron.

A great gift for any fan—at $2.50

A radio fan will appreciate a "spare" Radiotron, just as an autoist appreciates a spare tire. But the Radiotron—a genuine RCA Radiotron—costs only $2.50. If you note what make of set a man owns, any dealer can tell you which *type* of Radiotron he uses, and you can give him exactly what he would choose for himself.

Radiotron UV-201-A, standard high-vacuum tube for storage battery sets.

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Every owner of a Radiola Super-Heterodyne can bring his set right up-to-date with the latest improvement, if you give him the new dry battery power Radiotron UX-120, and the adapter. The adapter costs but $1.50. And this new tube means great volume with better tone than ever!

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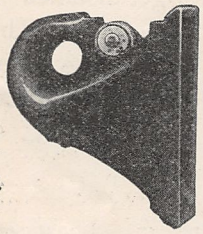
For EVERY Radio Set

A stunning piece of furniture that restores order in the room where you have your Radio! No more cluttered table-tops, nor litter of equipment under-foot.



Non-Vibrant Ceramic Horn
The clearest tone producer on the market. Made of special composition which defeats vibration.

No unsightly horn in evidence, either! This console has its own loudspeaker, inbuilt. It's out of sight, but with very apparent tonal superiorities. For it has the highest-developed type of unit. With horn built of special non-vibrating, extra-hard, ceramic material. Produces clear non-vibrant tone.

There's ample room for everything; space for *largest* A and B wet batteries—or battery eliminator—required for any home set; and for a big charging outfit, too.

Finished in mahogany, or walnut color. Dainty design of parqueterie on two front panels. Top, 38 in. x 18 in. Substantially built; the product of a 40-year-old furniture maker.

The price, forty dollars, is for the *complete* console and includes the loudspeaker horn and unit. Thousands of dealers are showing this artistic addition to home radio equipment.

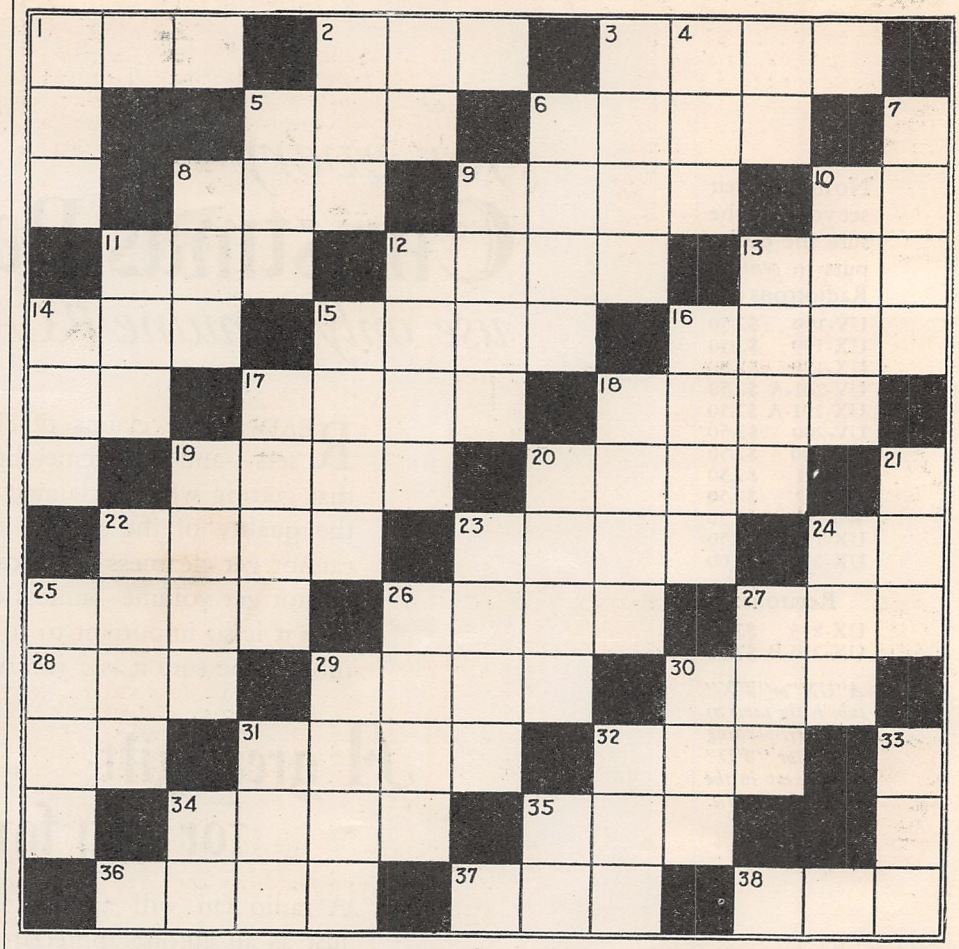
Rear View—Set Hooked Up

Price, $40
West of Rocky Mts., $42.50

Windsor Furniture Co.
1426 Carroll Ave.
Chicago, Ill.

Call Letter Cross-Word Puzzle

By PHILIPPE A. JUDD



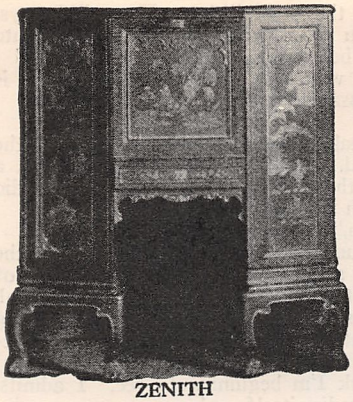
WHEN you tire of cussing the static, try this. It should take your mind off the weather conditions for half an hour or so. The blank spaces are to be filled in with the call letters of the broadcast stations whose locations and wave-lengths are given above. Enthusiastic fans should be familiar with the greater part of these call letters, though some of them are, no doubt, out of the range of your set. Your call book and radio map will take the place of a dictionary when solving this puzzle. Where two or more stations have the same location, the wave-length will indicate the right one. The solution will be given in the February issue.

HORIZONTAL

	Location of Station.	Wave-length.
1	Pittsburgh, Pa.	275
2	Honolulu, Hawaii	270
3	Joliette, Ill.	242
5	Denver, Colo.	322.4
6	San Francisco, Calif.	278
8	Kansas City, Mo.	365.6
9	Knoxville, Tenn.	250
11	Detroit, Mich.	352.7
12	San Antonio, Texas	263
13	St. Louis, Mo.	273
14	Utica, N. Y.	273
15	Philadelphia, Pa.	394.5
16	Indianapolis, Ind.	227
17	Boulder, Colo.	261
18	Superior, Wis.	242
19	Atlanta, Ga.	278
20	Buffalo, N. Y.	240
22	Cleveland, Ohio	270
23	Roanoke, Va.	229
25	Pitman, N. J.	231
26	Northfield, Minn.	336.9
27	San Jose, Calif.	240
28	Dallas, Texas	261
29	New York, N. Y.	492
30	Newark, N. J.	233
31	Pullman, Wash.	330
32	Charlotte, N. C.	360
34	Wilmington, Del.	266
35	Denver, Colo.	283
36	St. Louis, Mo.	261
37	Portland, Ore.	492
38	Washington, D. C.	261

VERTICAL

	Location of Station.	Wave-length.
1	Oakland, Calif.	360
2	State College, N. M.	348.6
3	Baltimore, Md.	254
4	Washington, D. C.	468.5
5	Los Angeles, Calif.	395
6	Hollywood, Calif.	227
7	Manila, P. I.	270
8	New Orleans, La.	280
9	University Place, Neb.	280
10	Ann Arbor, Mich.	229
11	Atlanta, Ga.	428.3
12	Tampa, Fla.	273
13	Rossville, N. Y.	273
14	Schenectady, N. Y.	379.5
15	Indianapolis, Ind.	263
16	New York, N. Y.	273
17	San Diego, Calif.	244
18	U. S. R. C. A.	226
19	Boston, Mass.	256
20	Fargo, N. D.	244
21	Chicago, Ill.	535.4
22	Olympia, Wash.	220
23	Pittsburgh, Pa.	461.3
24	Chicago, Ill.	447.5
25	Philadelphia, Pa.	250
26	Columbus, Ohio	293.9
27	Kukak Bay, Alaska	263
29	Dallas, Texas	475.9
30	Springfield, Mass.	333.1
31	Seattle, Wash.	360
32	Cincinnati, Ohio	422.3
33	Honolulu, Hawaii	360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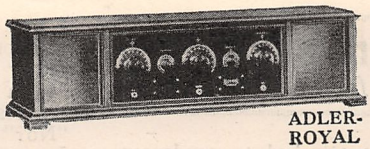
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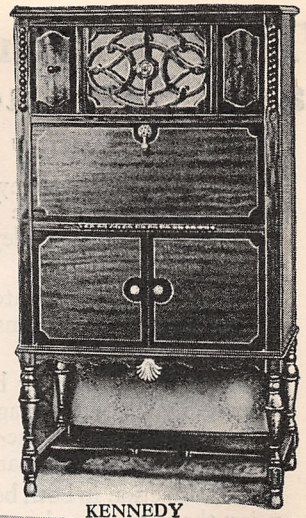
DERESNADYNE

GLOBE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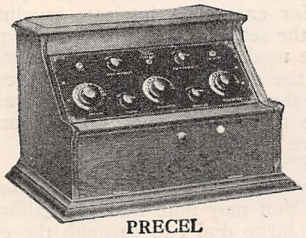
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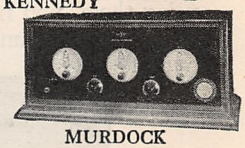
MOHAWK

PFANSTIEHL

MUNN-LANDON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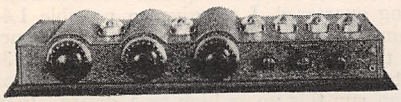
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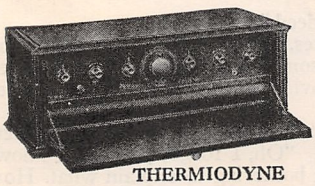
Standard on the finest
THORDARSON
Super
AMPLIFYING TRANSFORMERS
THORDARSON ELECTRIC MANUFACTURING CO. *Chicago, U.S.A.*
WORLD'S OLDEST AND LARGEST EXCLUSIVE TRANSFORMER MAKERS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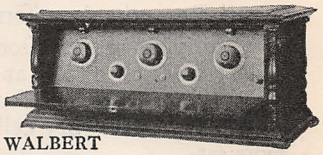
RADIODYNE

MERCURY

HUNTINGTON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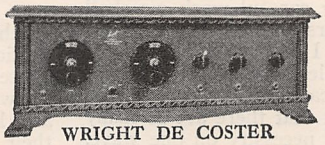
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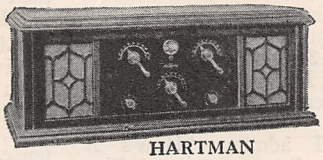
HOWARD

MU-RAD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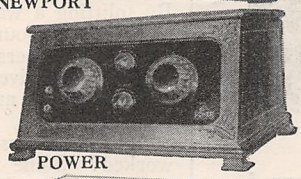
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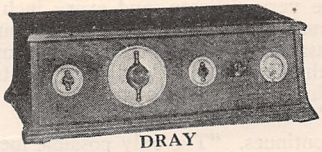
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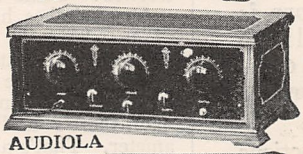
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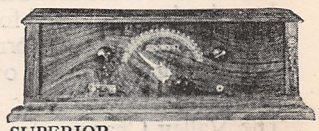
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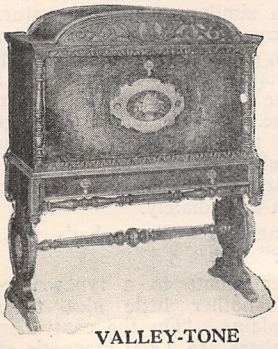
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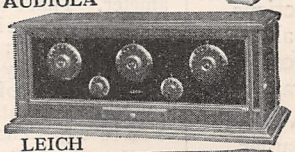
ELKAY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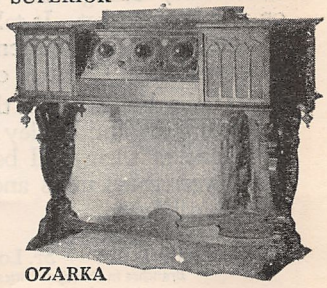
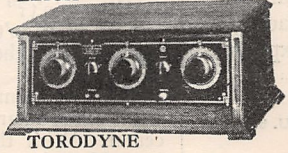

OZARKA

SILVER-MARSHALL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There's Economy and Satisfaction

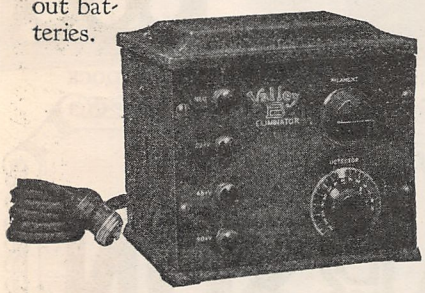
in these Valley units

You will find both economy and satisfaction in the use of the Valley B-Eliminator and the Valley Battery Charger.

Economy in the B-Eliminator because it stops forever the expense of buying new B batteries. . .

Economy in the charger because it recharges your own storage battery at home overnight at one-tenth the cost of service station charging. . .

And satisfaction in both because, by using them, you need never miss a program on account of low or worn-out batteries.



THE VALLEY B-ELIMINATOR operates from ordinary light socket; provides a steady, noiseless flow of B current *at a constant voltage all the time.* With it, there can never be any decrease of signals or frying noises due to low B batteries. Volume is maintained. Reception is uniformly good. For receiving sets of from one to eight tubes. Costs less at the start than wet B batteries. Costs less in the long run than dry cells. Much more satisfactory than both.

THE VALLEY BATTERY CHARGER is the only charger needed for all radio storage batteries. Its correct 6-ampere charging rate makes overnight charging a possibility.

The Valley Charger also functions on any lamp socket. It takes about a dime's worth of current for an average charge. Quiet in operation.

Most radio dealers handle the Valley B-Eliminator and Valley Charger. Any one of them will be glad to show you these units and explain their advantages.

Radio Division
VALLEY ELECTRIC CO. ST. LOUIS, U. S. A.
Branches in Principal Cities

Valley Electric

Radio Wrinkle Contest

(*Continued from page* 995)

tor lead on mine is attached to condenser shaft, which makes connection with the tin foil on the rotor but not on stator. The thickness of the mica insulation used will depend upon the capacity of the condenser desired.

If permanence is desired, the bearing holes may be reinforced with short pieces of metal tubing just large enough to work over condenser and vernier shafts. A rubber band placed around the circumference of rotor disc may aid to keep vernier from slipping.

Contributed by E. Weber.

The Master Laughs It Off

(*Continued from page* 963)

"What's that? Sounds like a cigarette ad."

Wifie offers a grin in response, which I don't bother to translate.

We plays matinee and evening, and when we sedans homeward Irene's tucked in amongst the robes. She's a good kid, and I ain't worried. I notices, however, that she's gotta lotta books with her. She being a reader, I don't think to inquire until I helps her out at home. Then I observes—they're all books on radio!

I realizes this must be one of those times when I'm supposed to remember something, so I stays shut. But I've gotta idea I'm on.

The next day is the Day of Rest, and no kidding. We actually gets up early so's to have more time to loaf. For my part, I buzzes over to The Master's along about ten A. M. Calendars don't mean a thing to him; Sunday and Monday are like as two beans in a bowl of soup.

"Oh, hello, Joe," he says, in his usual absent way, and I sees he's got something heavy on his brain. So I sits down and watches. I usually can't sit no more than ten minutes without yelping, so I finally gets up and inquires what's it.

"Oh, merely a close tuner," says The Master. "I think by careful work we shall all be splitting meters in the near future."

"Splitting what?" I asks.

"Meters, or wave-lengths," repeats Jerry. "Present-day broadcasting is very much hampered by the fact that there are so many stations operating by necessity on one wave. By splitting a wave into, say, quarters, then we can have four stations in one block, one at 360, the others at 360¼, 360½ and 360¾ meters, respectively. In this manner we can quadruple the number of stations without interference."

"Three cheers," I admits. "How's it worked? Some radically new principle?"

Jerry shakes his head. "Oh, no," he replies. "Merely intensifying the normal method. It's crude now, of course. Come, I'll show you the device."

We hoofs it into the next room. On the wall there's a dial about four feet in diameter. That's all.

"Whassa idea?"

"Simply this: when you try to tune in with an ordinary three- or four-inch dial you are incapable of moving the dial in small enough segments to permit close tuning. You've experienced this, of course?"

"Who ain't?" I replies. "But how's this worked? Won't it be just as hard to twist this as any other dial? Is it balanced, or something?"

"One at a time," smiles Jerry. "You see, with an ordinary dial, you twist from the center. With the large dial, the movement is guided from the rim. See—this small nob, and pointer? And the calibrations on the wall? Meter by meter, isn't it?"

I gets the possibilities. "I see," I says. "And you figure you can split a meter into parts by being able to tune more evenly?"

"In a way, yes, although the tuning is not necessarily done by hand."

"No?"

Jerry takes me into the room back of the large dial. Here's the set, together with a machine that don't look no more like a radio than hash resembles its constituents.

"Go on," I urges.

"You understand that a movement on the rim of a small dial—barely the thickness of a cigarette paper—is, on the large dial, almost an eighth of an inch. By dividing that eighth of an inch into quarters, fractional tuning is made easy."

"I think I'm beginning to see," I admits.

"The radio itself embraces no new principle, save for extremely intricate winding. As you see, the set is of the single-dial type. I could have used a gear ratio and reduced the size of the dial, but it is very difficult to eliminate the excess play in a gear train. Between the set and the dial, on the same shaft, you see the remote controller."

'Oh, do I?" I remarks.

"Yes," says The Master, heart and soul in things. "You may note that the calibrations on the large dial run through the entire circle, or 360 degrees. Each degree being quartered, I am given a possible 1,440 tuning positions. At the present arrangement of the set, my range is from zero to 360 meters, by quarters. By adding loading coils I can run this up as high as I desire—10,000 meters, if necessary."

"Huh?"

"Yes, indeed."

I meditates. "Interesting, and maybe convenient, in some ways," I states. "But where does it provide anything new, or any new use?"

Tht Master looks surprised for a moment, then smiles. "Oh, I forgot you didn't know," he says, not bothering to explain what. However, he finally does give me an inkling.

"During war, or even for clandestine purposes during times of peace, it is often necessary to transmit secret messages immediately. There are, of course, ordinary means by which this can be accomplished, none of which, however, are entirely without means of detection, particularly if the information is such that the mere fact of its having been sent would interfere with plans later on. In the past year there has been considerable traffic, mostly illegal, through the split-wave process. Only recently has this fact been known; a concern bought out the inventor and kept the process a secret, using it for their own ends."

"How do they do it?"

"Merely by building a transmitter and a receiver, each tuned to the precise agreed-upon wave-length, say 345½ meters. These outfits are very delicate, and every inch of wire, from aerial to ground or counterpoise, must be accounted for. You know yourself that no ordinary radio set can tune much within two meters at a time."

"True."

Jerry continues. "The only possible means of interception of these waves has been the building of a similar set, which, naturally, necessitated knowing the prearranged wavelength. That, of course, is out of the question for ordinary usage. Tuning for a split wave with the average set is just so much waste of time. By giving the message in some foreign tongue, or code, even chance reception would never be attributed to any secret organization. But with my tuner I can find them immediately."

"Yeh," I agrees. "But what's this remote control?"

The Master points to a typewriter-like keyboard. "Another little idea to save time," he explains. "On the controller, as I have said, there are 1,440 magnetic stops. On this keyboard there are 15 keys, nine of which are numerals, one a cipher, three ¼,

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½ and ¾, respectively, one a clutch and the other a wave-shift key. Thus, if you want wave-length 274½, you first tap key 2, then key 7, then key 4 and last key ½. Then press the clutch key, and the controller revolves and stops at 247½. For any wave above 360 meters, tap the wave-shift key once for each 360 above the original. The total range at any one time is only 360 meters, be it between zero and 360, or 5,000 and 5,360, and so on. Figuring a maximum of 10,000 meters, as it is now wired, the total is 40,000 possible tuning points. That range will take in anything within present-day reason."

"Oi!" I yelps. "But listen: if you don't know what wave's being used, won't you have to try them all before hitting the right possibility?"

"Admittedly," agrees Jerry, not at all fazed. "I counted on that. So I devised a relay whereby the controller will automatically stop on any wave that is being used. I just hold down the three-quarter keys, press in the wave-shift, and keep the clutch in. By this means I can cover the entire 30,000 quarter-wave possibilities in 15 seconds! Naturally, anyone using secret means of transmission would not use a full meter, so I can find my man at most within half a minute. In fact, I can cover the total 40,000 points in considerably less than a minute."

"They shall not pass, eh?" I grins. "Pretty clever, I think——"

What I thinks is interrupted by the appearance in the doorway of Doris and Irene. This latter lets out a yelp and skips over to Jerry.

"Oh, you've got one of those new type variometers!" she gurgles.

I've half a mind to tell her The Master's got several of all the new types, to say nothing of a lot that're ahead of their times. But Jerry almost radiates.

"Why, yes," he admits. "How did you know?"

Irene's an actress, no kidding. She gives The Master that look of combined surprise and annoyance.

"How do *I* know?" she repeats. "Why, Mister Lawson, don't you know that I'm a radio experimenter, too?"

Jerry didn't, but is pleased. And he continues to be pleased, to say little of being greatly surprised at Irene's knowledge. Oh, I gives her credit, she knows her wavelengths. For the lady calls everything by its right name, and discusses problems with The Master like a real ham. To say that Jerry's delighted is putting it mild; he's almost fanatical.

"Why, Joe," he says to me, on the quiet, "she's the first girl I've ever known who could carry on an intelligent conversation concerning radio. She's wonderful!"

"Aw, so's your old man," I grunts. I knows the signs.

Jerry ponders a moment. "Why, yes, he was. "What made you think of him?"

"Wasn't he your father?" I comes back, quick, wanting to burst, but not daring. Jerry smiles, puzzled, and returns to Irene.

Eventually Doris says she's got some calls to make and will I come or must she drag me. Oh, I ain't dumb, especially when I sees Jerry offer Irene a work apron and explain the why of something she don't know no more about than a brass monkey knows evolution. But we beats it, and leaves the two alone. It's after six before Irene returns.

She and Doris confabs on the q.t. for a while, then Irene bolts down a cuppa coffee, reads in a radio book for a few minutes, and then does a nose-dive back to The Master's. It's eleven when she gets back. With any other man I'd be suspicious; with Jerry—well, he's so safe he's disappointing.

So on through the week. Irene's with us at the show, but at home we don't see no more of her than we does the other side of the moon. All the explanations I gets is that she's building her own design transmitter. I stays away from Jerry's, three making the well-known crowd, but once I drops in on a friendly errand.

Her outfit is tightly boxed; even The Master ain't seen it, although he's done most of the work—not knowing it. He proudly gives Irene all the credit. Actually, he thinks she done it! Why, I saw her get around him in a bit of wiring in a way that'd make our best diplomat give himself up. I don't say nothing, but I keeps as much of an eagle eye on them as the gallon of hard cider Doris smuggled in will permit.

So it goes on for two weeks. By this time Irene's really learning; she could wind a spider-web coil all by herself!

One drizzly fall Sunday night Doris yanks me away from my fire and suggests that we trot over and bring Irene home. Inasmuch as that lady's been making the distance alone so far, I don't see the need, and says so. Which does as much good as a grid-leak in the ground wire. We goes.

Irene's busy at something, and Jerry's explaining how he figures there won't be no more electrons if the ion emigration keeps up. However, I feels like I've reached the limit, and says so, asking how's things.

"Oh, fine, Joe," assures The Master. "Irene's set is almost ready. It's her own design, you know."

"Oh, is it?" I asks, polite. "What's the principle?"

The Master shakes his head. "Irene won't say as yet, but she's promised to give a demonstration as soon as the circuits are completed."

"And that time's now," says Miss O'Leary, pulling her head outa the box. We're all primed, me especially.

"You see," explains Irene, "radio communication really isn't what it should be. There's too much interference."

"Actually?" I inquires. She musta thought that one up outa her own head. Doris runs a pin into my arm, so I subsides.

"Yes," continues Miss O'Leary. "My transmitter utilizes an entirely new method, one which requires extreme selectivity for reception. In fact, there is today but one set that can receive my messages properly."

I has an idea I knows where that set is, but my arm hurts, so I stays outa the ether.

"That set is with Solly Finklebloom, in Chicago."

"Solly Finklebloom!" I yelps. "Why, he used to be awful sweet on you!"

Irene reddens a bit, and Doris pins me to silence.

"He was a very good and kind friend," says Irene, stiff. "He now manages Station WOOF, in Chicago. I shipped him my special receiver some time ago, and have just finished the large transmitter."

Some time ago, was it? Could it be possible Irene's serious? But after all I've seen, heard and imagined it don't sound reasonable. However, I stays shut.

"Solly awaits my orders for a test," explains Irene. "We have made them over short distances, but this will be the first major experiment."

The Master's been listening, close and careful. I'm hoping he'll detect a flaw in the proceedings, but he don't. Finally he speaks.

"I take it you infer that you can transmit a message which I cannot pick up?" he inquires.

"Indeed I can."

"Really?"

"Certainly."

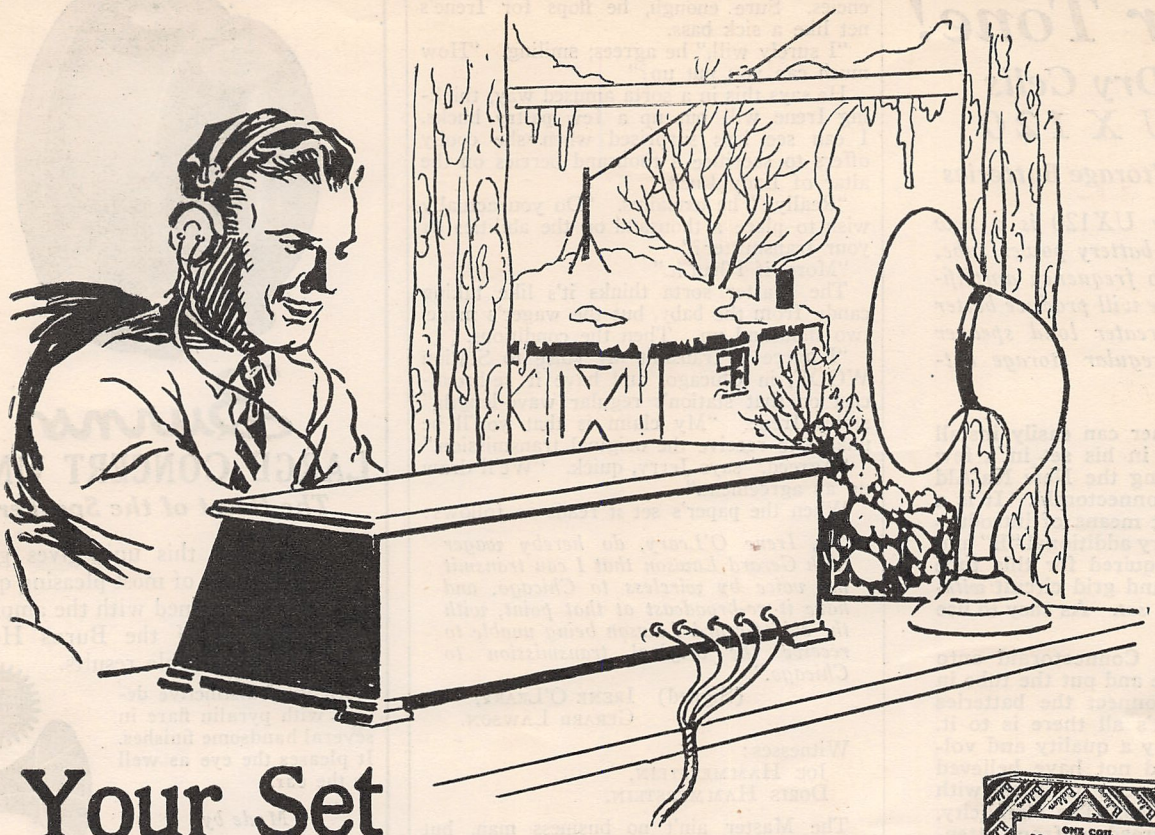
"I don't believe it. How?"

Irene smiles. "That's a secret. But I can do it."

"You'll have to prove it—and I'll wager you can't, at that."

Miss O'Leary looks up, innocent. "You want to bet?"

Every man has a gambling instinct, and



Your Set

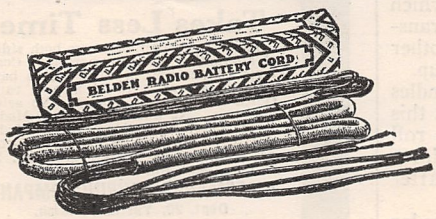
Needs a Beldenamel Aerial and a Belden Battery Cord

A *Belden Radio Battery Cord* makes a compact, neat installation of the battery wiring between the A and B-batteries and the receiving set. The cord contains five wires, each color-coded for easy identification of the circuits. The wires are all rubber-covered and securely encased in a firm brown glazed braid.

No more accidental short-circuits between loose wires, when you use a Belden Radio Battery Cord. It saves tubes and batteries. It eliminates the fire hazard that is present when poor wiring is used.

A *Beldenamel Aerial* is a stranded aerial wire, each strand being coated with several layers of baked Beldenamel. This coating prevents oxidation and corrosion of the copper conductors, and thus insures a low aerial resistance, even after the Beldenamel Aerial has been in service for a long time.

Bare copper wire rapidly corrodes and increases in resistance. Beldenamel cannot corrode. For this reason, it is endorsed by leading radio engineers as the best aerial. Install a Beldenamel Aerial for permanence, volume, and distance.



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Note: The UX120 is a new three volt dry battery power tube. Used for audio frequency amplification, this tube will produce better quality and greater loud speaker volume than regular storage battery tubes.

Any set owner can easily install a UX120 tube in his set in a few minutes by using the New Na-Ald Number 120 Connectorald. It is a simple, efficient means of introducing the necessary additional "B" and "C" voltage required for this tube into the plate and grid circuit *without rewiring the set.* As easy to use as an adapter.

Just slip the Connectorald onto the UX120 tube and put the tube in the socket. Connect the batteries and—well, that's all there is to it. Except to enjoy a quality and volume you would not have believed possible. No need to fuss with charging batteries. The simplicity, economy and freedom from attention characteristic of dry cells is now combined with the real volume and quality previously obtainable only with storage battery tubes.

The No. 120 Connectorald is suitable for all sockets—metal neck as well as insulated. For sale at radio, electrical and hardware stores. Price, $1.00.

Na-Ald Adapters

Na-Ald Adapter 419-X

With this adapter the Na-Ald de Luxe Socket will take the new UX199 small base tube. Price, 419-X, 35 cents.

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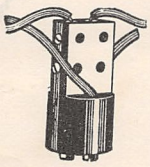
No. 420-X, equipped with cables, enables owners of Radiola Super-Hets to get the great increase in volume and clarity the new UX120 tube develops. Price, 420-X, $1.25.



Na-Ald Adapter 421-X

No. 421-X makes possible the shift from WD-11 to UX tubes. Especially designed to enable owners of Radiolas III and III-A to enjoy the improved operation the new tubes provide. Price, 75c.

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Jerry's no different from the rest, except that he's got a little more jack for emergencies. Sure enough, he flops for Irene's net like a sick bass.

"I surely will," he agrees, smiling. "How much can you put up?"

He says this in a sorta amused way, thinking Irene will put up a few paltry bucks. I can see he's surprised when she coolly offers to sacrifice a thousand berries on the altar of Lady Luck.

"Really?" he exclaims. "Do you actually wish to place a thousand on the abilities of your transmitter?"

"More, if I had it."

The Master sorta thinks it's like taking candy from the baby, but the wager's made, two thousand up. Then the conditions.

"I agree to transmit my voice to Station WOOF, in Chicago, and have it re-broadcast on that station's regular wave-length," states Irene. "My claim is that you'll be unable to receive the original transmission."

"Agreed," says Jerry, quick. "We'll draw up an agreement."

When the paper's set it reads as follows:

I, Irene O'Leary, do hereby wager with Gerard Lawson that I can transmit my voice by wireless to Chicago, and have it re-broadcast at that point, with the said Gerard Lawson being unable to receive the original transmission to Chicago."

(Signed) IRENE O'LEARY,
GERARD LAWSON.

Witnesses:
JOE HAMMERSTEIN,
DORIS HAMMERSTEIN.

The Master ain't no business man, but he's got confidence enough to sell oil stock in Wall Street during a financial crash.

"I shall hate to have you lose that thousand," says The Master. "I really hope your device works."

"Tonight's Sunday, and we'll set the date for Thursday night, as soon as we get home from town. Say, one-thirty?"

"Fine," agrees Jerry, smiling. He don't need that thousand no more than a snake needs an umbrella, but it's the spirit of the thing. As for Irene, that one grand looks like the mint to her, and I don't savvy. But I stays silent.

Thursday comes, a fine night for radio. Irene's transmitter's been set up in my joint. We've several impartial witnesses amongst the townspeople, Doris and Doc Maxwell watching over The Master while me and the town cop supervises Irene's layout. There's half a dozen others at each end. Irene has only one condition.

"While I'm transmitting nobody's to say a word or make a noise," she states. "I want my voice to be clearly understood."

"Fair enough," I says, and the bunch sits down over by the door and takes in the details.

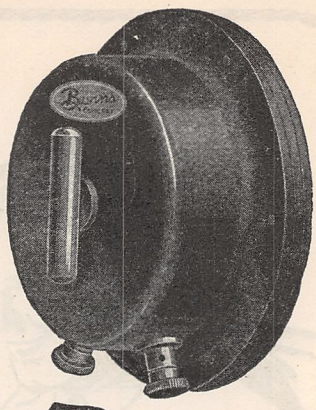
Irene's outfit is all inside the box except for the usual dials, controls and such, which are on the panel. There's a coupla transformers on the floor, and one or two other articles. But the big secret is locked up.

Irene's learned, I can see that. She handles the dials like an old-timer, fussing with this and that as she waits for the time to roll around. Finally her watch says one-thirty to the second, and she begins to talk, after receiving the OK signal from Chicago.

Over at The Master's he has his regular set tuned to WOOF's normal wave-length, and his automatic set all lined up ready for immediate service. He won't miss no more than a dozen words, and one sentence correctly received will win him the bet.

Over at my place we has a stenographer taking down Irene's words in shorthand. Her line runs along for about five minutes something like this:

"It was a balmy winter's evening, and a goodly crowd was there. Cannons to the right of them, cannons to the left of them,



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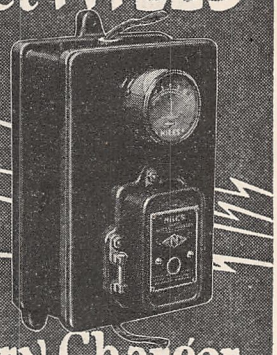

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The only charger that uses both sides of alternating wave in charging. Converts 72 per cent of current into battery charge—at 8 to 10 ampere rate. Quick action. Low upkeep. No acids or fumes. No bulbs to break. Model A for 6-volt batteries, $19.00; Model AB for 6-volt and 24-volt to 120-volt batteries, $21.00. West of Rockies, $1 extra. Ask Any Radio Dealer

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are used by over 200 broadcasting stations, where they do the same difficult job they are called upon to do in your customer's receiving set. Are you familiar with our plan for merchandising these batteries through the radio dealers? If not, read the column at the right.

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Cleveland, Ohio

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Months of operation have proved that this plan is effective, and profitable for all concerned.

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Have your local Willard Service Station show you this advertising and explain the details of this new and practical plan for selling radio storage batteries. The advertisements are signed:

Sales and Service through
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Authorized Radio Dealers

Appropriate signs and window cards will identify you as an Authorized Dealer. Booklets and other valuable selling helps are also furnished.

Your Nearest Willard Service Station is Your Nearest Willard Jobber

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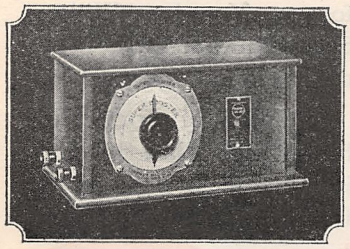
All over the country there is a tendency to make radio programs better and better during 1926. The finest talent in every section is being engaged to improve the *quality of entertainment*. And you can make a corresponding improvement in the *quality of your reception* with the aid of the

Super-Booster

It Improves Radio Reception



The Super-Booster is the best preventative of interference, static and fading troubles ever devised.

The increased volume, clear and realistic reproduction, big saving on batteries and tubes are additional Super-Booster advantages.

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cannons in front of them, volleyed and thundered. You're a better man than I am, Gunga Din. Romeo, Romeo, wherefore art thou, Romeo?"

"What the deuce!" mutters the steno. "The kid's goofy."

At the conclusion of the test Irene smiles. "It sounded funny, but it was only to make the experiment fairer. Since reception of but one sentence will lose me the bet I gave Jerry all possible leeway by reciting well-known quotations. If he got the first lines he could hazard the rest. Oh, I'm fair enough."

Well, we hot-foots over to Jerry's, Irene being assured and calm while I'm thinking she's a long way from the new sable coat she wants. But the moment I opens the door I sees which way victory's turned. Jerry's face is the picture of despair.

"We got the re-broadcast," he says, faint, "but not one line of the original."

They compares notes and they tallys to a syllable. I can see it means a lot to The Master, since it renders his invention of no use. But he smiles, weak, and concedes the bet. After the cash has been handed over to Irene the big question is put. How did she do it, and why?

Irene laughs. "I've not been granted a patent as yet," she explains, "so I can't tell you for a while. You'll know in good time."

Jerry's worried—he don't even miss the cash, but the thought that his quarter-wave outfit is null and void gives him the willies—and I sees a too-satisfied smile on Irene's face. Doris is also smothering a big-time grin. We goes home, and finds waiting for Irene a message that her folks are back, and want her to come home right away. Irene packs her bag, and leaves. I don't like the looks of things, especially since Doris is in such good spirits.

"Laugh away, lady," I warns. "Wait'll I find out!"

"Why don't you, big boy?"

"How can I?"

Doris grins. "Irene didn't take her transmitter with her, did she?"

"No," I admits, "but it wouldn't be right to peek into it."

Doris almost yells. "Aw, go on!" she begs. "I'll take the blame!"

Something in the way she says it gets my nanny, so I skips upstairs into the radio room. Sure enough, the outfit's still there, all nicely panelled. I gets a screwdriver and opens the front of the set.

The ease with which the panel comes off surprises me, but that ain't a tenth of the jolt I gets when I looks inside.

Her transmitter consists of some of the stalest air I ever lunged. Aside from that—nothing!

I beats it downstairs. "Say, she did too take her transmitter," I yelps. "It ain't here!"

"Everything's there that ever was," says Doris.

"Don't kid me, girlie," I replies. "You can't transmit no radio messages with an empty box."

I goes back up, Doris following with a copy of the agreement.

"Who said anything about radio?" asks Doris. "This was Jerry's punishment for snubbing Irene that night at the show."

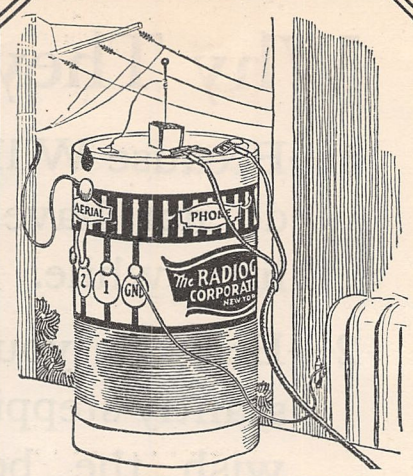
"Punishment——"

Doris points to the agreement. "If Jerry hadn't been so excited he'd have worded the agreement himself. Note this 'transmit my voice by wireless to Chicago'; where does it say 'radio'?"

"Ain't wireless and radio the same? Did she use a telephone?"

Doris gives a good cackle. "You see, Solly Finklebloom is Irene's old sweetie, and he's still cuckoo over her. All she did was to make a *phonograph record* of her voice, and send it to Solly to transmit!"

I'm speechless. "Why, the little crook!" I yelps. "She violated——"



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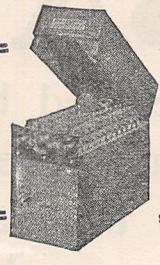

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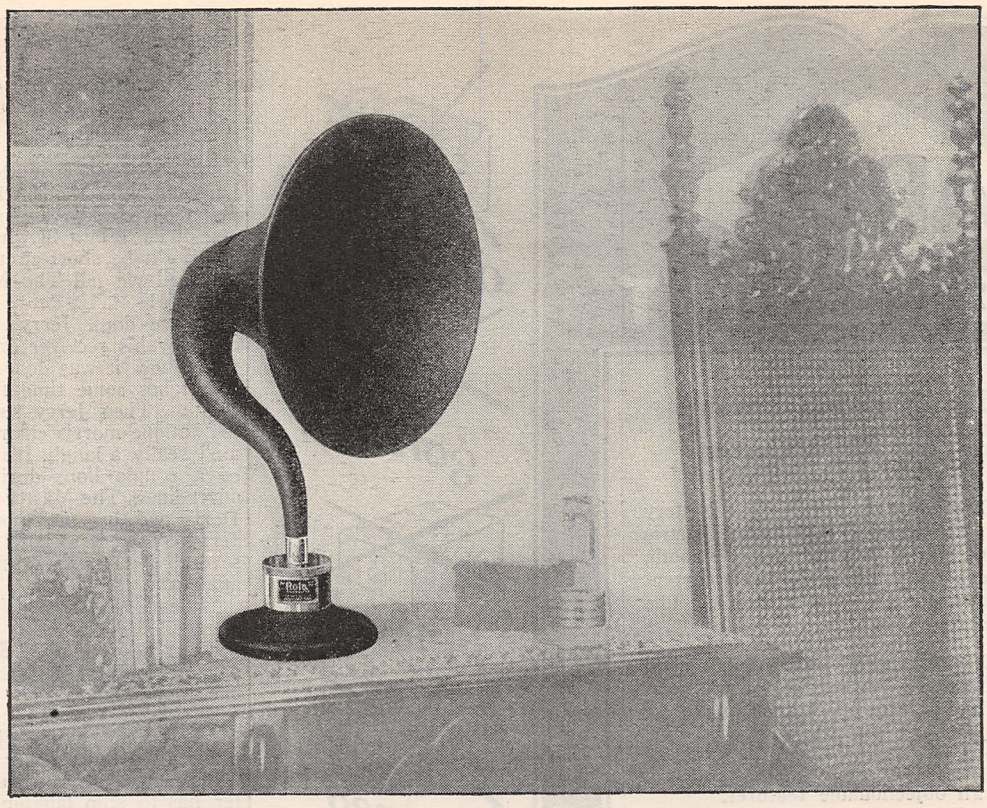

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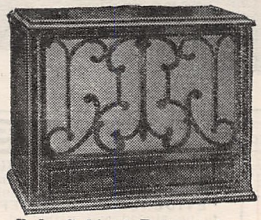

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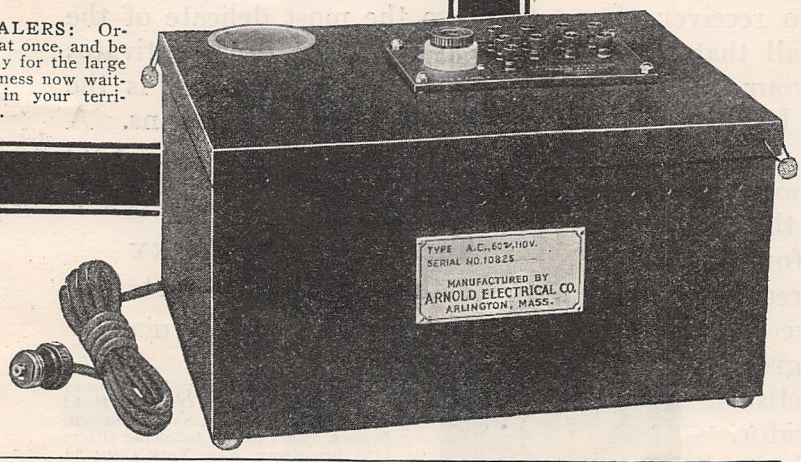

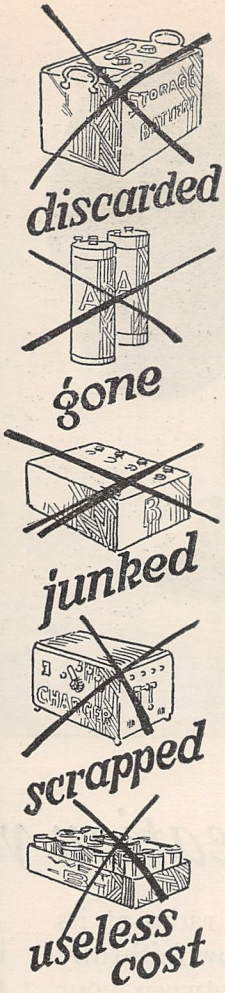

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"No, she didn't," says Doris, quick. "The agreement says to 'transmit my voice by wireless to Chicago.' She transmitted her voice, didn't she? She didn't use any wires, did she? The agreement doesn't say 'wireless telegraphy', does it? Where do you stand?"

"I'm sitting," I mutters, but I can't help laughing. "So that's why she was so careful about timing, and why she didn't want any of us to butt in while she was speaking. Well, I'll be short-circuited!"

"Shall we tell The Master?" asks Doris. "Let's!"

So we does. Jerry's still there, figuring out why his receiver didn't receive. We explains how it was done.

It takes some time for the facts to percolate. Then Jerry suddenly sits down in his antique morris chair and laughs. Only it ain't really a laugh. It's more like the sound of a coupla lions during an argument. I never knew The Master had so much volume. Doris and me are both surprised, while Jerry continues to howl in merriment. After several minutes he subsides. Then he roars again.

"*Phonograph record!*" he howls. "The little devil!"

Then he sets up. "So that was her revenge, was it? I snubbed her by not tossing back her balloon?"

"Yes."

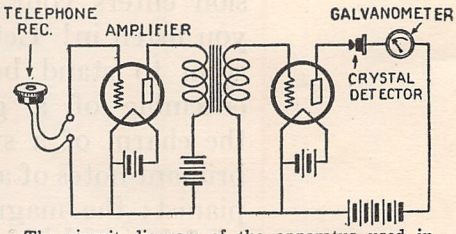
Jerry roars again. "The little devil! I certainly have to give her credit!"

"I'll say you have," snaps Doris. The Master has to stop laughing to figure that one out.

Testing Building Materials by Radio

(*Continued from page* 965)

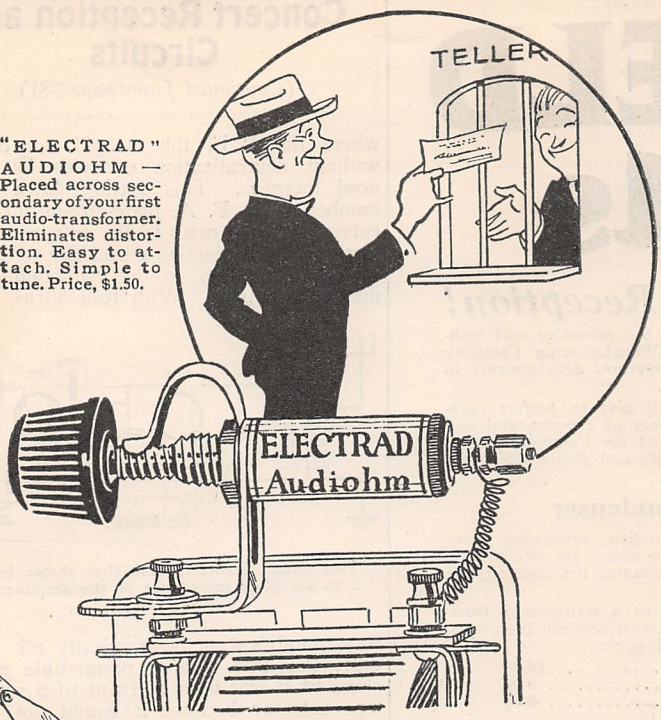
"The sound chamber is built massively of concrete," states Dr. Eckhardt in describing the room in which these sound-radio-electricity-mechanics experiments are being conducted. "Two measuring rooms are located, respectively, above and beside a source room, the latter being separated from the remaining structure by air spaces. Panel openings



The circuit diagram of the apparatus used in testing building materials.

are so designed that the transmitting panels, when sealed into position, form the only bond between the two parts of the structure, excepting the common ground on which they stand. The vertical panel opening is used for the study of wall structures, the horizontal panel opening for the study of floor and ceiling structures. The partition walls are built 6 x 7 x ½ feet. When the panels are sealed into position the effective transmission area is 5 x 6 x ½ feet. These test specimens are larger than any for which transmission data have so far been found."

In other words, this soundproof chamber is constructed to meet the peculiar requirements for which it was built. This sound chamber, so called, is detached from the remaining structure in which it is housed, resting on a separate foundation. "Soundproof" is a relative term, but this chamber is about as proof against sound as any structure of its kind in the United States.



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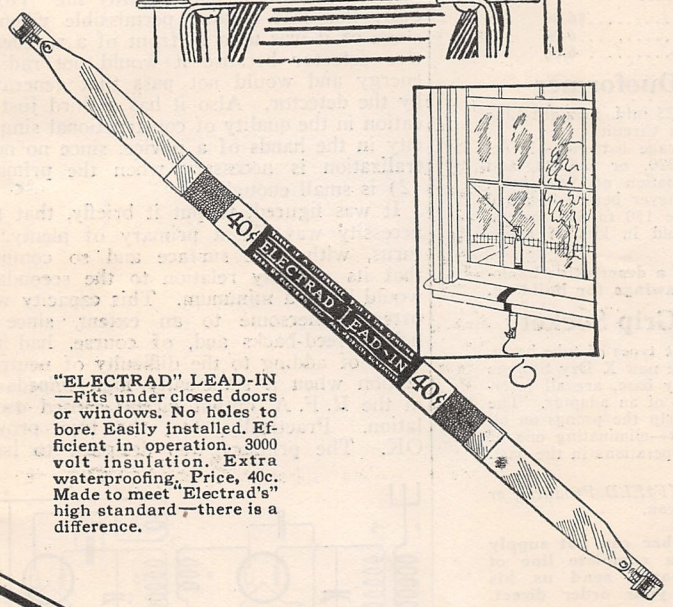
Buy "ELECTRAD" Radio Products from your dealer. If he can't supply you write us, sending his name.



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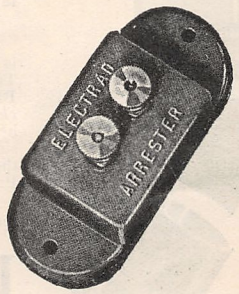

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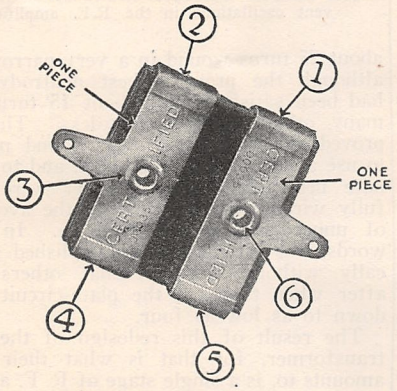

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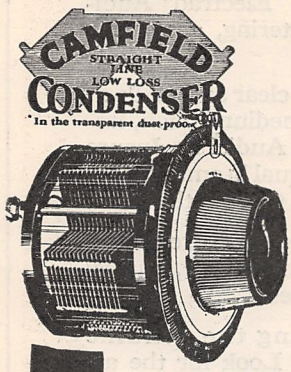

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The Camfield Type 22 Duoformer

is used with the Camfield Type 886 .00025 mfd. Straight-Line Condenser in building the new Duodyne Circuit.

This circuit—using either dry or storage batteries—is designed for the new power tubes, CX220, or UX120, and CX112, or UX112. It gives a combination of *Selectivity, Sensitivity, Volume* and *Tone Quality* never before obtained in a five tube set. Wave Length Range 150 to 550 meters. Camfield Duoformers are boxed and sold in kits of three. Price $10.00 complete.

Send 25c for "The Duodyne Circuit," a descriptive booklet with complete instructions and drawings for building.

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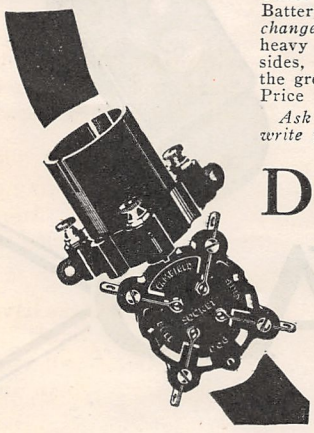

is designed to accommodate three different types of tube bases. Tubes having the Navy standard base, the new X Dry Storage Battery base, or the new X Dry Battery base, are all *interchangeable* in this socket without the use of an adaptor. The heavy phosphor bronze contact springs grip the prongs on all sides, insuring *absolutely perfect contact*—eliminating one of the greatest troubles encountered in set operations in the past. Price 65c each.

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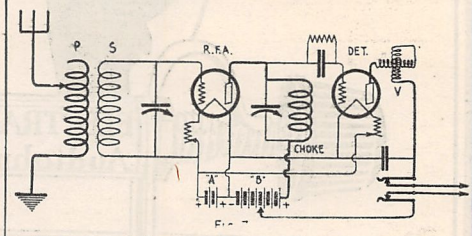
Concert Reception and Circuits

(*Continued from page* 981)

where the R. F. tube would not oscillate without neutralization or with but slight need therefor. This cutting down of the number of R. F. A. plate-circuit turns was carried in some cases to the extreme of four turns. This embodies a sacrifice of amplification in relation to the reduction of the number of turns. With four turns, by the



This circuit is better than that shown in Fig. 2 as the plate impedance of the amplifier tube can be tuned.

way, amplification is practically nil. However, this last became permissible when a stage of it was used in front of a regenerative detector because it would not radiate energy and would not pass that generated by the detector. Also it has a third justification in the quality of constructional simplicity in the hands of a novice, since no neutralization is necessary when the primary (2) is small enough.

It was figured, to put it briefly, that the necessity was for a primary of plenty of turns, with little surface and so compact that its capacity relation to the secondary would be at a minimum. This capacity was often bothersome to an extent, since it helped feed-backs and, of course, had the effect of adding to the difficulty of neutralization when a sufficiently high impedance in the R. F. A. output circuit caused oscillation. Practically, too, the idea proved OK. The primary was designed to have

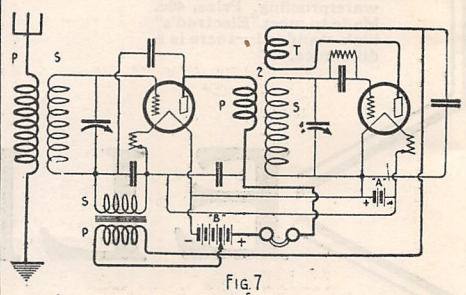


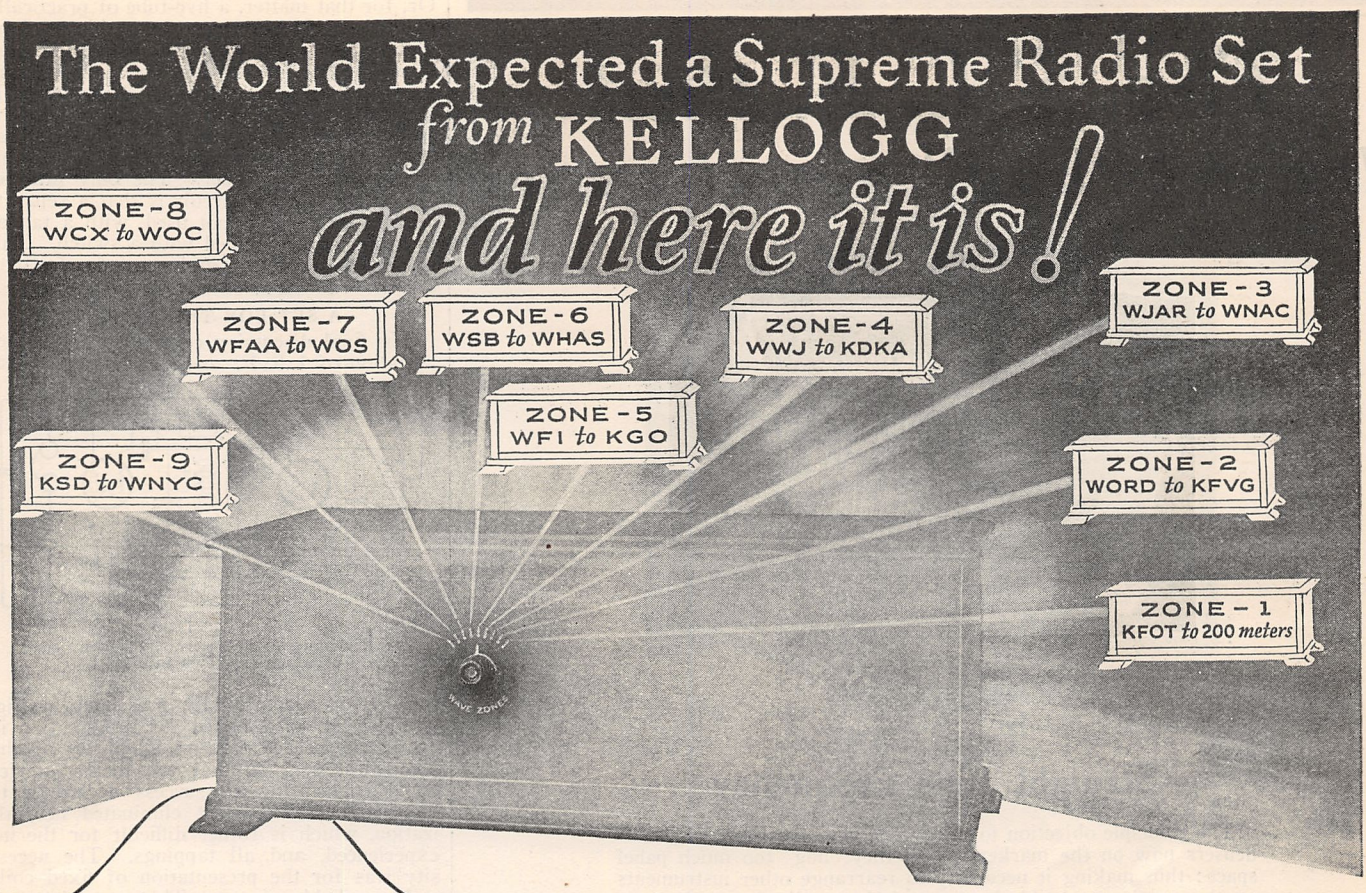
FIG. 7

The Harkness Reflex circuit, shown above, uses the Rice method of neutralization to prevent oscillations in the R.F. amplifier.

about 25 turns wound in a very narrow slot, although the previous best neutrodyne set had been satisfied with about 15 turns, and many others with ten or less. The idea proved so good that it was found possible to use a 199 tube as the R.F.A. and to eliminate neutralization, if the set were carefully wired with attention to the avoidance of unnecessary capacity effects. In other words, this circuit had accomplished practically without sacrifice what others were after when they cut the plate-circuit turns down to as low as four.

The result of this redesign of the R. F. transformer, for that is what their work amounts to, is a single stage of R. F. amplification of unusual power, which, when the detector is made regenerative (the B-D circuit, so-called, always contains a regenerative detector) produces as good volume as, and apparent better sensitivity than, any previous five-tube neutrodyne (assuming two stages of audio on the circuit, or four tubes).

The World Expected a Supreme Radio Set *from* KELLOGG *and here it is!*



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$125.00

WAVE-MASTER
Brown Walnut Console with inbuilt horn
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A Separate Circuit for Each 40 Meter Wavelength Band!

Kellogg — for 28 years makers of precision telephone instruments and equipment — producers of quality parts since radio began — Kellogg has perfected a radio receiver worthy to bear the Kellogg name.

In the illustration we visualize this wonderful engineering achievement.

In the new WAVE-MASTER there are nine separate circuits—one for each 40 meter wavelength band. Each circuit gives that maximum efficiency heretofore found only in one short section of the dials of ordinary radio frequency sets. Each circuit brings within the range of the tuning dial *a different group of stations.*

How wonderfully simple tuning becomes! Merely set the pointer to the wave zone in which you are interested and bring in the desired station with the single Selector dial.

This remarkable tuning dial actually has a tuning range of 540 degrees—equal to 1½ times around a complete circle — over three times the station finding range of any other set.

All other radio frequency sets have variable capacity which must be tuned, usually with three different dials, to balance with their inductance coils.

The WAVE-MASTER'S inductance is not fixed but variable and is easily and quickly tuned, with the one Station Selector dial, to balance the fixed capacities.

Write for full description and complete technical explanation of the Wave Master circuit. Ask for folder No. 1-A. Please mention your radio dealer's name.

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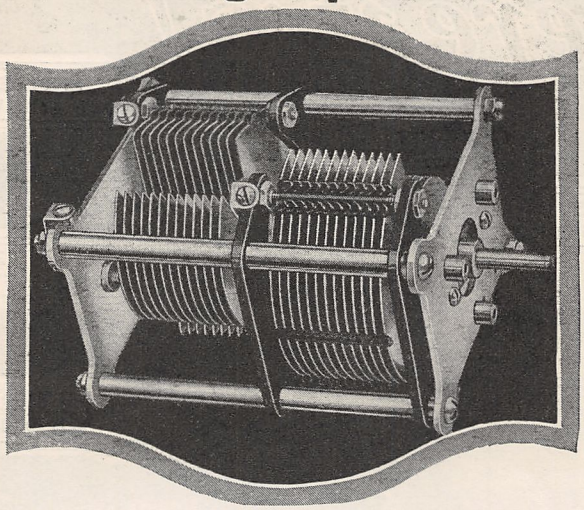
The S. L. F. that doesn't "hog" panel space



Type 374
Straight Line Frequency

The principle objection to many Straight Line Frequency condensers now on the market is that they "hog" too much panel space; thus making it necessary to rearrange other instruments on the panel or rebuild the set entirely to allow enough room for the scythe-like sweep of the S. L. F. rotor.

The new General Radio type 374 S.L.F. condensers eliminate entirely all such difficulties. They occupy the same panel space as the well known types 247 and 334 condensers—and no more. In fact they may be used interchangeably with those condensers since the mounting holes are the same.

By using smaller rotor plates of correct shape and double the number of plates General Radio condensers have a straightline frequency calibration curve without the mechanical disadvantages encountered in the average S.L.F. with fewer plates of larger area. The assembly of the type 374 condensers with respect to bearings, soldered-plates, and correct spacings are the same as the types 247 and 334.

For further description and prices ask to see them at your local dealer's or write for our latest Bulletin 923-N.

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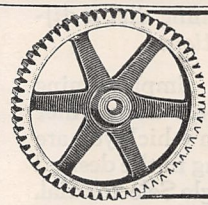

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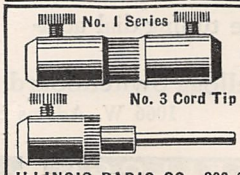

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Or, for that matter, a five-tube of practically any type. It produces these things along with good selectivity, ease of tuning and, providing decent audio transformers are used, no inherent musical distortion. It may be classed as very decidedly among the few well-designed circuits ever proposed for the use of the broadcast listener or his brother fan, the tinker. The only fair regret regarding the circuit is that a separate antenna circuit was not used, with a tapped primary coarsely tuned with a switch. This would have resulted in improved selectivity and no obnoxious difficulty in tuning.

A SET FOR THE NOVICE

The final discussion centers about another variation of 1 R. F., and regenerative detector. It is schematically presented in Fig. 9. The set, as designed for presentation in an article, needed to have simplicity of the completest sort so that the merest novice could construct with success according to instructions. This fact eliminated neutralization, which is rather difficult for the inexperienced, and all tappings. The necessity was for the presentation of fixed coils and a reliable circuit. That was done.

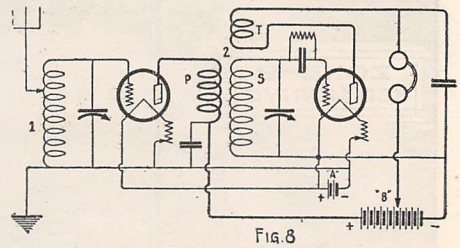


FIG. 8

The Browning-Drake receiver, the basic circuit of which is shown in Fig. 1.

Oscillation was taken care of by a reduction of the primary (2) turns to 6, although up to 10 can be used without danger of oscillation, provided wiring is done carefully. However, no one can prophesy a novice's wiring, so the writer played safe. Selectivity was made certain by inductively coupling the antenna circuit in addition to the small size of the primary (2), the size of which makes a material difference. Sensitivity and volume were presented in the regenerative detector, accomplished by the variometer in the plate circuit. The usual two stages of audio-amplification were tacked on. The simplicity of the set is immediately apparent. Its construction can be accomplished with the use of standard parts, such as a couple of standard R. F. units and a variometer. However, the fact that a variometer is used for regeneration instead of a tickler does not alter the fact that the circuit contains the backbone of Fig. 1, with bare detail variation—as is the rest described in this article, although this one is rather the poorest of the lot. It can be improved by the use of a variably tapped antenna circuit, the B. and D. type of primary (2) design and by neutralizing the R. F. A., in which case it would become slightly preferable to the so-called Browning-Drake circuit itself.

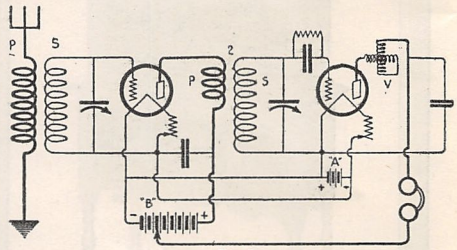
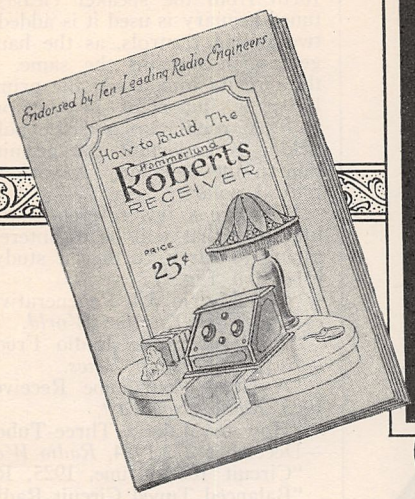


FIG 9

This circuit, the constants of which are given in the text, is an excellent one for experimentation.

A word about the practical performance and points of these variations of this circuit is best thrown in here. Tuning is similar in all cases. The regeneration control is



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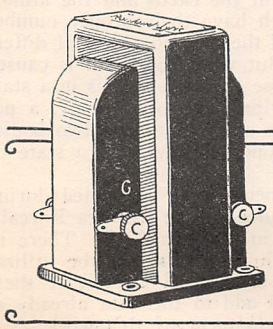

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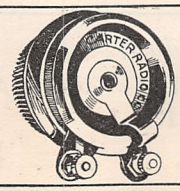

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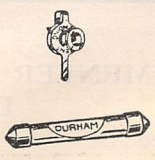

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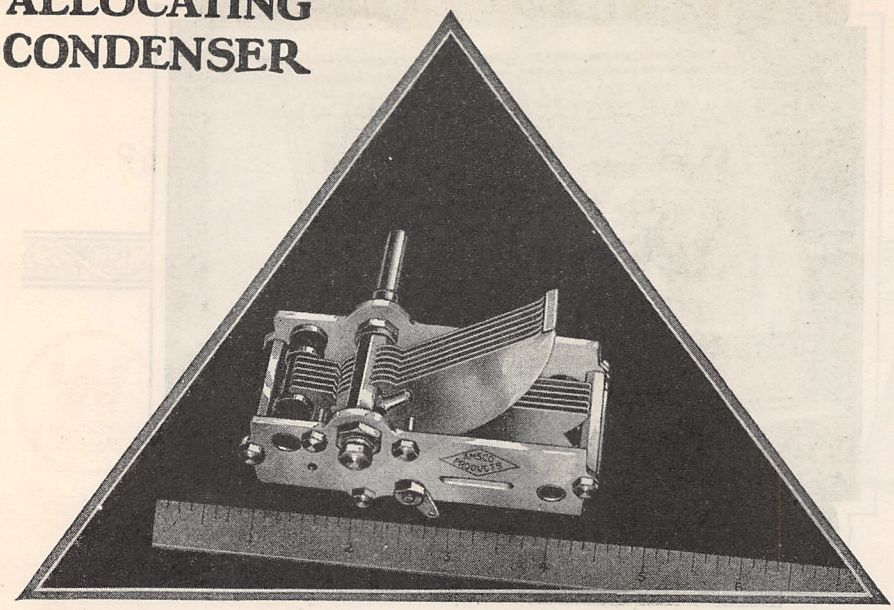

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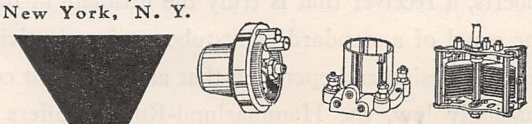

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rotated for oscillation and temporarily left alone. The other two controls are adjusted for maximum volume of the usual station whistle. Then the regeneration control is reversed to the point where oscillation stops. When one arrives there, provided that the volume is sufficient, the concert will break forth from the speaker clearly. Where a tuned primary is used it is added to the other two tuning controls, as the handling of regeneration remains the same. In building the circuits into a set, the primary (2) polarity is important in the prevention of R. F. A. oscillation and the polarity of the tickler is important for permitting oscillation in the detector. A variometer has no critical polarity.

Here are a few references to present-day literature that will be of interest to anyone caring to carry further a study of circuits based on Fig. 1:

"The Metric 3-1 Regenerative Receiver."—*New York Evening World.*

"A Regenerative Radio Frequency Set."—*Buffalo Evening News.*

"A Good Four-Tube Receiver."—March, 1925. *Radio Broadcast.*

"How to Make a Three-Tube Superflex."—December 27, 1924, *Radio World.*

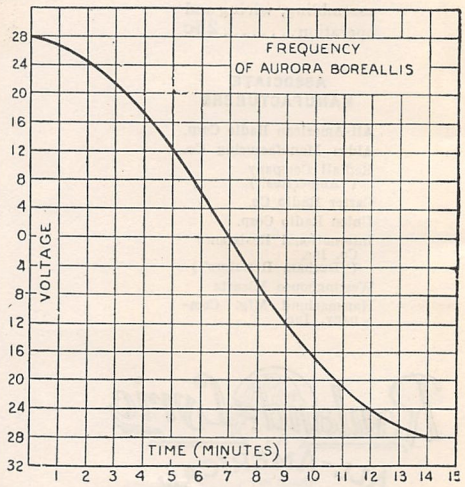
"Circuit 103."—June, 1925, RADIO NEWS.

"Balanced Tuned Circuit Radio Frequency Amplifiers."—March, 1925, *Radio.*

New Facts About the Aurora Borealis

(*Continued from page* 964)

again the voltage was not so great, and when the hue in the sky had vanished the voltage reading was zero. The change in position of the streaks of light in the sky explains the various voltage readings I received. Even when the voltage was barely noticeable the frequency of oscillation was not varied in the least.



This curve shows how the voltage varies from maximum to minimum in 15 minutes. This curve is approximately a sine wave.

It is evident that when the Aurora Borealis is not present the earth and the atmospheric layer each have their proper number of electrons and there is no potential difference present. But when the earth is caused to throw off these electrons and is in a state of oscillation with some other body, a potential difference exists until the two bodies resume their proper charges and a state of rest occurs.

These experiments were conducted during the last appearance of the Aurora Borealis in this vicinity, in the year 1919. There is, at present, much discussion on the utilization of atomic energy. I hope that these experiments will add to the data already at hand in the development of this work.

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ANSWER:

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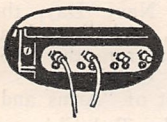
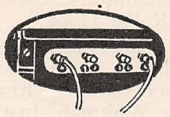


TO recharge one or two-cell radio "A" batteries with a Rectigon, merely adjust "snap" terminals as shown above. Takes but a moment.

TO recharge three or six-cell radio "A" or automobile batteries merely adjust "snap" terminals as shown above. Very simple.



TO recharge eleven to forty-eight-cell "B" batteries merely adjust "snap" terminals as shown here. (An instruction sheet packed with every Rectigon.)

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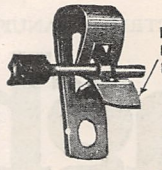

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An Improved Laboratory Super-Heterodyne

(*Continued from page 983*)

fect satisfaction as on any super, by removing the antenna coil and connecting the loop with its inside end to post 6 of the coil socket, its center tap to post 4 or 5, and its outside end to post 3. This assumes a spiral loop, of 18 turns, about 20 inches mean diameter with turns spaced one-half inch between centers. Stranded loop wire should be used—not Litz. For shorter waves, fewer turns will be required—say about eight for the 100- to 200-meter band and about four for the 50- to 100-meter band.

In the case of some standard loops, wound with few turns, it may be necessary to add a turn or two to cover the desired maximum range up to 550 meters.

How to Follow WRNY

(*Continued from page 959*)

cast of "Mary, Mary," including the principals, Mary Saxon and Harry Puck were there another evening and it must not be forgotten that on Navy Day, the "Captain Jinks" company, including Ada May and chorus, broadcast from the U.S.S. *Illinois*, or that Theatre Guild players brought us many of the cast of "Arms and the Man."

"Whose Birthday Today" is now in mighty good hands. The mysterious Miss Catell takes names and birthdays and tells us what they mean, numeralogically and astrologically, and, although it has nothing to do with the subject, Alfred McCann has been doing the same thing with "Food," Dr. Block with "Mental Advice" and Dr. Finkel with "Diet."

I think that one of the loveliest of all features has been the "Twilight Musicales" on Sunday afternoon, although if Dr. Christian Reisner continues to bring in men like Senator Copeland, Dr. Buckner, and others, he may lead the other features.

As I look over the light opera presentations, I recall that the Mme. Andres Parker Singers gave "The Pirates of Penzance," and the Gordon Hampson Light Opera Company presented "Robin Hood."

Do you know that WRNY had the distinction of bringing in more political speakers than any other station? Frank Waterman, ex-Governor Whitman, Justice McKee, George Gordon Battle, Senator Walker, Ida Slack, not to mention many others.

Do you know that we had this month such speakers as Henry W. Taft and Judge Alton B. Parker?

Of course, all the ladies know what "Pictorial Review Says," and everybody knows that Charles Dana Gibson comes to WRNY with that laughable feature, "Life's Jokes."

You already know that Ben Bernie is back, don't you? Yes, he is—with his famous orchestra.

As I look back over the book, the biggest of all things that we have done at WRNY looms up—the WRNY Artists' gathering. By the way, I must tell you that the front of our big book is a picture of a photo taken that night. About 300 were present and everybody broadcast for one minute. I wonder how many listened in that night.

The Radio Theatre Players presented "Nothing But the Truth" this month, and the listeners all said that they could "see" the whole thing, as well as hear it. The Radio Art Theatre gave a performance of Moliere's "The Affected Young Ladies."

The Women's Hour is getting to be quite a feature. Mrs. Edgar Cecil Melledge has been taking charge of one of these groups.

I will see you again next month.

Equip your set with
Balkite Radio Power Units
They provide unfailing, uniform current for both circuits

Equip your set with Balkite Radio Power Units. They improve and simplify radio reception. With their use your current supply is unfailing and always exactly what is required for each circuit. They reduce the amount of attention you give your set.

The Balkite Battery Charger is entirely noiseless in operation. It can be used while the set is in operation.

The Balkite Trickle Charger converts your "A" battery into a permanent "A" power unit that supplies full "A" current at all times from the light socket.

Balkite "B" II is also well known. It was the outstanding development in radio last year. It eliminates "B" batteries and supplies plate current from the light socket. It fits any set.

The new Balkite "B" at $35 is especially designed to serve sets of 6 tubes and less. With such sets it will perform exactly as does Balkite "B" II with sets of larger "B" current requirements.

Noiseless—No bulbs—Permanent

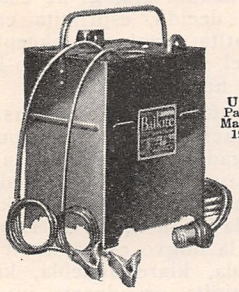
All Balkite Radio Power Units are based on the same principle. All are entirely noiseless in operation. They have no moving parts, no bulbs, and nothing to adjust, break or get out of order. They cannot deteriorate through use or disuse—each is a permanent piece of equipment with nothing to wear out or replace. They require no other attention than the infrequent addition of water. They do not interfere with your set or your neighbor's. Their current consumption is remarkably low. They require no changes or additions to your set.

An "A" battery, a Balkite Charger and a Balkite "B" constitute a complete, trouble-free radio power equipment, one that is economical, unfailing in operation, and eliminates the possibility of run-down batteries.

Manufactured by
FANSTEEL PRODUCTS COMPANY, Inc.
North Chicago, Illinois

FANSTEEL
Balkite
Radio Power Units

FOR THE "A" CIRCUIT

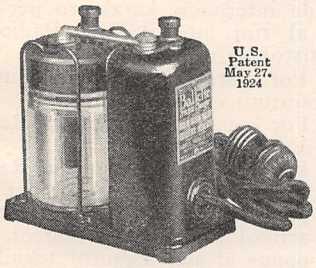


U. S. Patent May 27, 1924

Balkite *Battery Charger*

This popular battery charger can be used while the radio set is in operation. If your battery should be low you merely turn on the charger and operate the set. Charging rate 2.5 amperes. Operates from 110-120 AC 60 cycle current. Special model for 50 cycles. Also for 25-40 cycles with 1.5 ampere charging rate.

Price $19.50
West of Rockies, $20
In Canada, $27.50



U. S. Patent May 27, 1924

Balkite *Trickle Charger*

Can be connected to the usual 6-volt battery and left on permanent (or trickle) charge. Automatically charges the "A" battery and supplies "A" current from the light socket.

With small batteries (4-volt and small 6-volt) can be used as an intermittent charger of the usual type. Or it can be used as a trickle charger if a resistance is inserted to cut the charging rate to the needs of the set.

As an added convenience to trickle charging some owners add a switch which cuts out the charger and turns on Balkite "B" during operation, making both power supplies automatic in operation.

Charging rate .4 to .5 amperes. Size 5½ x 2¾ x 5 inches. Fits in usual dry cell compartment. Current consumption 1/10c per hour. Operates from 110-120 AC 60 cycle current. Special model for 50 cycles.

Price $10
West of Rockies, $10.50
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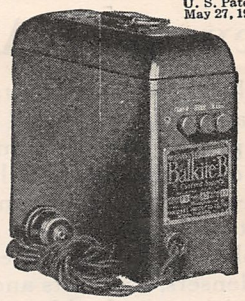
FOR THE "B" CIRCUIT

U. S. Patent May 27, 1924



Balkite "B"

Eliminates "B" batteries. Supplies plate current from the light socket. Operates with either storage battery or dry cell tubes. Keeps "B" circuit always operating at maximum efficiency, for with its use the plate current supply is never low. Requires no changes or additions to your set. No bulbs—nothing to replace. Requires no attention other than adding water twice a year.

A new model, designed to serve sets requiring not more than 20 milliamperes at 90 volts—practically all sets of 5 tubes or less and most 6 tube sets. Size 8¼ in. long, 8 in. high, 3¼ in. wide. Occupies about same space as 45 volt dry "B" battery. Operates from 110-120 AC 60 cycle current. Special model for 50 cycles.

Price $35
In Canada, $49.50

U. S. Patent May 27, 1924

Balkite "B" II

The most outstanding development in radio last season. Same as the new Balkite "B" but will fit any set including those of 8 tubes or more. Current capacity 40 milliamperes at 90 volts. Size 9 in. high, 6¼ in. wide, 7½ in. deep. Operates from 110-120 AC 60 cycle current. Special model for 50 cycles.

Price $55
In Canada, $75

The Unipower, manufactured by the Gould Storage Battery Company, is equipped with a special Balkite Radio Power Unit.

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You must have our catalog no matter what set or kit you want. Our line is complete and includes all popular sets.

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No matter what you want in radio—anything from a one tube to an eight tube set, kit, or semi-finished sets—anything in parts or supplies—any radio data—**it's in our wonderful catalog.**

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BOYS! Here's Money For You!

DO YOU want a steady income every week—extra money for football games, for the movies, and for Christmas Presents? You can easily earn it in your spare time and get dandy prizes besides by selling RADIO NEWS and our other popular magazines.

Start a business of your own by sending along your name and address on the coupon below—TODAY!

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Experimenter Publishing Co., Dept. RA-1,
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My Name Is.....

Address .....

City..... State.....

Progresso de Esperanto Lingvo de Radio

(*Continued from page* 971)

kunveniĝis en Ĝenevo dum aprilo, 1924, kun la unua celo de diskuti praktikajn rimedojn por atingi internacian konkordon pri la reguligado de ondolongecoj por la komuna bono. Ĝi estis plene reprezenta de tutmondaj radio-interesoj, ankaŭ havante oficialajn reprezentantojn de Svisujo, la Ligo de Nacioj kaj de la Universala Poŝta kaj Telegrafa Unuiĝo.

Aldone al la laboro supre menciita, la Konferenco konsideris la demandon pri helpa lingvo por internacia disaŭdigado. Vidante la konvinkigan demonstracion de la efikeco de Esperanto donita de la Konferenco mem, kies laboro estis estinta plimulte farita en tiu lingvo, la Prezidanto mem uzanta ĝin, ĝi ne estas surpriza ke la decido, esprimita en unuanime akceptita rezolucio, akceptis Esperanton kiel la Monda Radio-Lingvo. La rezolucio finiĝis jene:

"Ĉi tiu Konferenco rekomendas al ciuj disaŭdigaj stacioj ke ili aranĝu por perioda disaŭdigado en Esperanto almenaŭ unufoje semajne ĉe fiksita horo dum interkonsentita tago, kaj tiel multe kiel eble aranĝu por la disaŭdigado de Esperantaj lecionoj ĉar la lingvo estas montrita kiel facile lernebla, klare aŭdebla, kaj jam estas disvastigita grandparte inter aŭskultantoj en ĉiuj landoj."

INTERNACIA RADIO ASOCIO

Ci tiu Asocio estis organizata dum januaro, 1924, celante la unigon de ĉiuj interesiĝantaj en la aplikado de Esperanto al Radio. La celoj estas oficiale deklaritaj en parte kiel jene:

1. Por faciligi rilatojn inter Radio-uzantoj en ĉiuj partoj de la mondo per la internacia lingvo Esperanto.

2. Por provizi teknikan elpon kaj informon de internacia karaktero per Esperanto al tiuj intersitaj en Radio ĉu Esperantistoj aŭ ne-Esperantistoj.

3. (a) Por kuraĝigi la publikadon de Radio-literaturo en Esperanto.

(b) Por kompili la Esperanto-Radio-Vortaron.

(c) Por eldonidi **Internacian Radio-Revuon,** kiu, inter alia, per Esperantaj resumoj de originalaj artikoloj el diversaj lingvoj, disponos al siaj legantoj teknikajn dokumentojn ĝisnune nur akireblaj aŭ kompreneblaj per granda malfacilajo.

4. Por kunlabori kun Radio-kaj aliaj grupoj, naciaj aŭ internaciaj, en la plibonigado de la stato de Radio-uzontoj, kaj helpi al tiaj grupoj per ĉiu ebla maniero laŭ sia povo.

La Internacia Radio Asocio jam havas grandan anaron, disvastigitan tra pli ol tridek landoj. La Internacia Sekretario estas S-ro Harry A. Epton, 17 Chatsworth Road, London, 5E. Usona sekretario, J. D. Sayers, Box 223, City Hall Station, New York City; Kanada sekretario: C. C. McFarquhar, 163 University Avenue, Toronto. Jaraj kotizoj, inkluzive de bultenoj, 25 cendoj.

PROGRESS OF ESPERANTO, LANGUAGE OF RADIO

From the time when radio telephony ceased to be a mere hobby in the hands of amateur scientists, and became a factor in modern civilization, it has been increasingly evident that the aid of an international auxiliary language must be enlisted before the marvellous potentialities of this new science

Continuous, unfailing "A" Power

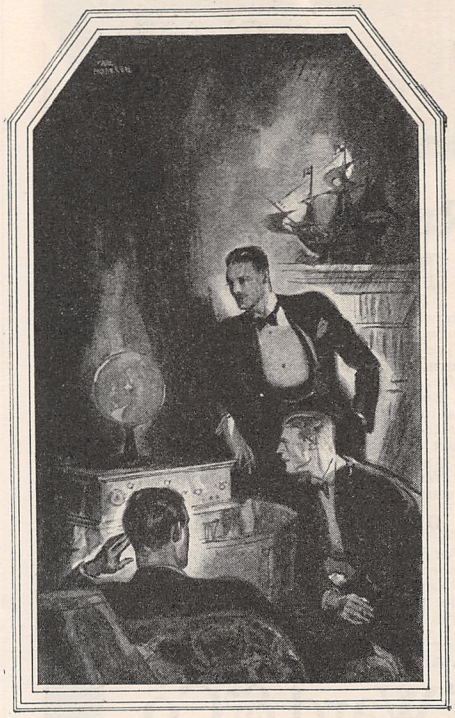
—in a single compact unit . . . that automatically replenishes itself

THE new Gould Unipower asks for a place in your set on this basis—that it will contribute more than anything else to the convenience, perfection and economy of operating your set—that it will give you the most that your money can buy—that it will banish "A" battery failure, the most frequent cause of poor radio reception.

Here are the facts about Unipower.

Unipower is a single compact "A" power unit that fits *inside* most radio cabinets. It takes the place of dry "A" batteries or of separate storage battery and charging units. It is *not* a battery eliminator and should not be confused with any other radio power device.

Unipower is quickly and easily installed. Just connect two wires to your set, plug in on your light current, and the job's done! Unipower is equipped with an exclusive Balkite charger of special design. Unipower will last you for years, and there are no tubes, bulbs, lamps or working parts that require frequent replacement.



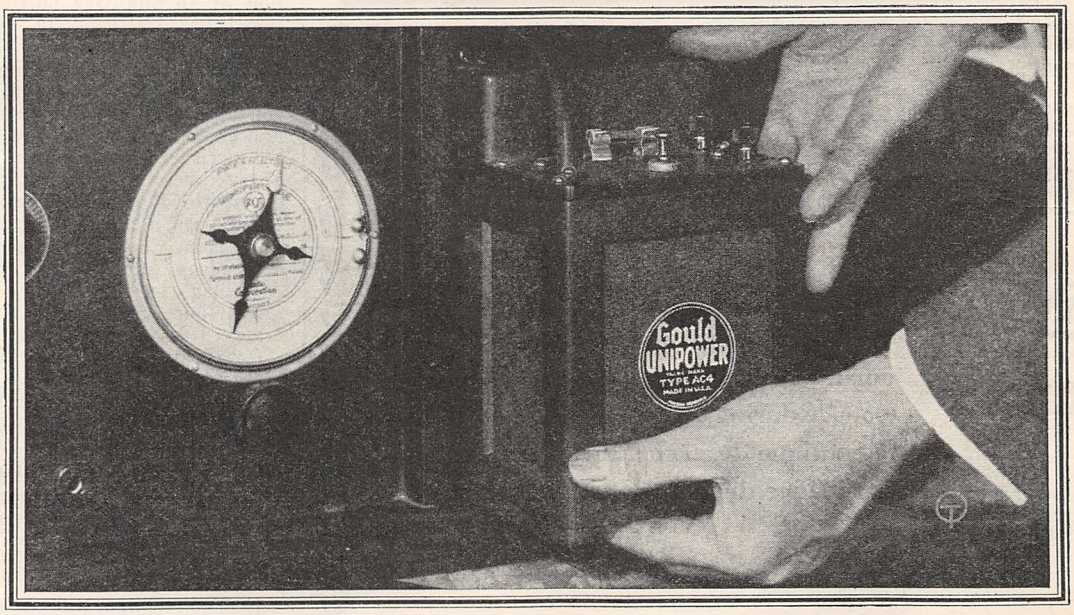
WITH UNIPOWER, YOU INSURE YOUR SET AGAINST "A" BATTERY FAILURE —THE MOST FREQUENT CAUSE OF POOR RADIO RECEPTION

A unique feature of Unipower is the single master control switch that governs the operation of your entire set. When the switch is ON, Unipower feeds your set rich, quiet power with neither hum nor noise. When the switch is OFF, Unipower *automatically* replenishes itself on a low trickle charge and with a minimum consumption of current—a few cents a month.

The first cost of Unipower is moderate—and the first cost is the last. When you also consider that Unipower banishes dry "A" battery renewals, or the bother of charging a storage battery, and increases the life of your tubes, you see how economical Unipower really is. You'll find that it pays for itself over and over again.

Decide to see the new Unipower today. The nearest radio dealer has it. Ask him for a demonstration. The Gould Storage Battery Co., Inc., 250 Park Ave., New York.

FREE! Write for interesting booklet, "Unipower, a triumph in radio power"



Unipower operates from alternating current, 110-125 V-60 cycle. It is supplied in two types. The 4 Volt type is for sets using UV 199 tubes or equivalent and retails for $35.00. The 6 Volt type is for sets using UV 201-A tubes or equivalent and retails for $40.00. West of the Rockies, prices are slightly higher. (Special models, 25-50 cycle, are available.)

Unipower

TRADE MARK

On when it's off — Off when it's on

Unipower fits comfortably inside most set cabinets. It is quickly and easily installed. Connect two wires to your set, plug in on your house current and you have continuous, unfailing "A" power of the highest quality and refinement instantly at your command.

Ward's New Radio Catalogue is Now Ready

Are you interested in seeing what is new in Radio—What is best and what has been approved?

And do you wish to know the lowest prices on tested sets, prices made without the usual "Radio profits?"

This Catalogue is a Complete Guide to Radio

Ward's is headquarters for Radio, with probably the largest retail radio department in the whole world.

This new 52 page Radio Catalogue shows everything in parts, batteries, cabinets, contains a list of stations, a radio log for recording stations. It shows the best of the new sets. One tube sets that give amazing results. Five tube sets with a single dial to turn. Think of tuning in one station after another by turning a single dial!

Every price quoted means a big saving to you. Everything offered is tested by our own Radio Experts. In fact, the best experts compiled this Catalogue for you.

Write for this 52 Page Book. It is yours free.

Our 53 year old Policy

For 53 years we have sold only quality merchandise under a Golden Rule Policy. You can rely absolutely upon the quality of everything shown in this Radio Catalogue.

Write to the house nearest you for your free copy of Ward's new Radio Catalogue. Address Dept. 2-R

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Montgomery Ward & Co.

The Oldest Mail Order House is Today the Most Progressive

Baltimore Chicago Kansas City St. Paul Portland, Ore. Oakland, Calif. Ft. Worth

The Aerovox Wireless Corporation sincerely wishes you

A Merry Christmas & A Happy New Year

We take this joyous occasion also to thank our many friends for their esteemed patronage during the past year; and promise to continue deserving their good will and confidence during the coming year.

AEROVOX

Manufacturers of Fixed Condensers

AEROVOX WIRELESS CORPORATION

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Insure your copy reaching you each month. Subscribe to Radio News—$2.50 a year. Experimenter Publishing Co., 53 Park Place, N. Y. C.

can be fully developed in a truly international sense. Ignoring national frontiers, the Hertzian waves carry the human voice over mountains and valleys, and across continents and oceans, knowing but one barrier, that of language. This barrier must be surmounted if wireless is to become a real link between the people of the world, bringing the best of each nation within reach of all. It is quite natural that Esperanto, already very largely employed as an international tongue in all spheres of human activity, should have invaded the new realm opened up by the pioneers of radio.

Beginning with a speech from WJZ, Newark, June 19, 1922, about Esperanto as the coming world radio language, the number of stations broadcasting about and in Esperanto have grown proportionately with the increase in the number of stations. Five discourses about Esperanto and one song in that language were broadcast in Europe and America in 1922. In 1923 about fifty such items were on the programs, over two hundred in 1924 and during the past year approximately twenty stations on both sides of the Atlantic have broadcast regularly *in* Esperanto. Many stations have been giving lessons in the language on the air. At the end of this article a list of stations using Esperanto or teaching it will be found. A recent report from Germany states that every station in that country is now giving a weekly programme in Esperanto. This great increase in the attention given to Esperanto by radio interests is largely accounted for by the recommendations of the Geneva International Conference in April, 1924.

THE GENEVA CONFERENCE

A preliminary Conference for an International Agreement on Wireless Telephony was held in Geneva in April, 1924, with the primary object of discussing practical means of arriving at an international understanding on the regulation of wave-lengths in the general interest. It was thoroughly representative of world-wide radio interests, having also official representatives from Switzerland, The League of Nations and the Universal Postal and Telegraphic Union.

In addition to the business mentioned above, the Conference dealt with the question of an auxiliary language for international broadcasting. In view of the convincing demonstration of the suitability of Esperanto provided by the Conference itself, of which the business had been largely conducted in that language, the President himself using it, it is not surprising that the decision, expressed in an unanimously accepted resolution, recognized Esperanto as the world radio language. The resolution ended with the following:

> "This Conference recommends to all broadcast stations that they arrange for regular broadcasting in Esperanto at least once a week at a fixed hour on an agreed day, and so far as possible arrange for the transmission of Esperanto lessons because the language has been shown to be easy to learn, clearly audible, and has already spread to a considerable extent among listeners-in of all countries."

INTERNACIA RADIO ASOCIO

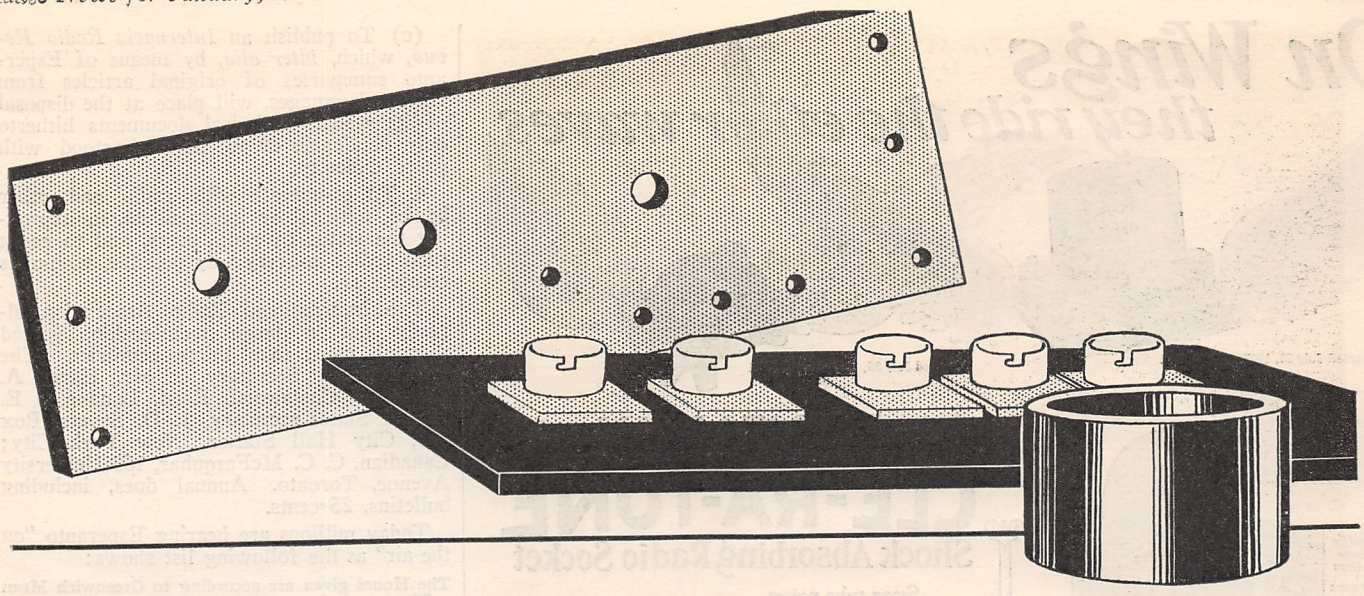
This association was founded in January, 1924, with the object of uniting all those interested in the application of Esperanto to radio. Its purposes are officially defined in part as follows:

1. To facilitate relations between radio users in all parts of the world by means of the international language Esperanto.

2. To furnish technical assistance and information of an international character by means of Esperanto to those interested in radio, whether Esperantists or non-Esperantists.

3. (a) To encourage the publication of radio literature in Esperanto.

(b) To elaborate the Esperanto Radio Dictionary.



The big advantage of Formica Panels

A HANDSOME finish that looks "like a million dollars" and stays so without discoloring, crazing, checking or changing in any way is one of the important characteristics of Formica. It makes sets easier to sell.

Formica has mechanical strength to provide a radio set with a thoroughly strong and sturdy frame work. It will not break in any ordinary accident. It will not warp and distort in humid weather throwing the instruments out of alignment or causing trouble.

The electrical qualities of Formica get better with use. It is an essential material in a high-grade set for base panels, terminal trips and similar parts.

The better finish, and greater uniformity of Formica have made it the preferred insulating material of the overwhelming majority of the leading American set makers.

VERI-CHROME PANELS

By the purchase of a controlling interest in the Veri-Chrome laboratories, the financial and production resources of the Formica Insulation Company have been placed behind this remarkable new process for decorating radio panels. Elaborate decorations can be produced much more rapidly and more economically than by engraving. Decorations designed by the leading American artists are offered. Tuning scales may be marked directly on the panel eliminating the standard dial and substituting pointers instead. The reduction in cost is large. Write for prices on complete panels finished in this way in quantity.

Dealers: Home set builders know and prefer Formica. It has been a highly profitable account for radio jobbers and dealers everywhere.

THE FORMICA INSULATION COMPANY

4618 Spring Grove Avenue, Cincinnati, Ohio

1 Formica is used by nearly all the leading set makers — and has for years been used by more set makers than any other material.

2 Formica is unaffected by weather and time — it lasts forever.

3 Formica in appearance is the finest of all panel materials and always remains so.

4 Formica's electrical qualities of every kind far exceed any possible requirement.

5 Formica has high mechanical strength and will not break in use.

6 Formica will not sag from heat or cold flow under pressure. It retains its dimensions. Everything you fasten to it stays tight and precisely where you put it.

7 Formica panels are sold in neat craft paper envelopes which assure you that you are getting the genuine.

8 Formica is one of the most widely approved materials in radio.

SALES OFFICES

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Chicago ..... 9 S. Clinton St.
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New Orleans ..... Whitney Central Bldg.
Pittsburgh ..... 422 First Ave.
San Francisco ..... 585 Mission St.
Philadelphia ..... 725 Bulletin Bldg.
Baltimore ..... 709 Title Bldg.
Habana, Cuba ..... 55 Calle Obispo
Boston ..... 6 Beacon St.
Denver ..... 1420 16th St.
St. Louis ..... 1362 Syndicate Trust Bldg.

APPROVED RADIO NEWS LABORATORIES 1925

FORMICA

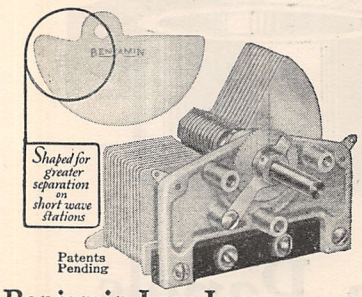
Made from Anhydrous Bakelite Resins

SHEETS TUBES RODS

Hear the Formica Orchestra over WLW every Tuesday evening from 9 to 10 Central Standard Time.

On Wings they ride the ether waves

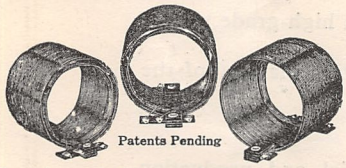
Patented July 25, 1925; May 2, 1911 — Patented July 25, 1925; May 2, 1911



Patents Pending

Benjamin Low Loss, Long Range Condensers

First of all a wonderful low loss condenser. The shape of the rotor blades eliminates bunching of stations on the lower side of the dial and makes tuning very easy. Unpolished silver plate finish. Friction disc on rotor shaft adjusts turning tension without loosening or throwing plates out of alignment. Made in three sizes: 13 plate for .00025 Mfd., 17 plate for .00035 Mfd., and 25 plate for .0005 Mfd. Drilling template furnished with each condenser.



Patents Pending

Benjamin Tuned Radio Frequency Transformers

Even in what has been considered an excellent set, it is astounding what an improvement in tone, quality, volume and selectivity the introduction of these coils produces. Low Resistance. Low Distributed Capacity. Space wound, air core; double green silk insulation—the nearest approach to an all-air dielectric construction and the highest type of inductance possible.

BENJAMIN CLE-RA-TONE Shock Absorbing Radio Socket

Stops tube noises.

Assures clear reception.

Four delicately adjusted springs support the socket and absorb all jars and shocks.

The Cle-Ra-Tone Socket "floats" above its base.

Bakelite, used wherever possible, insures sturdiness, long life and high insulation.

Flexibility of springs is not affected by stiff bus wiring.

Handy lugs make soldering easy.

Benjamin Cle-Ra-Tone Sockets prevent the transmission of outside vibrations into microphonic disturbances.

"Push" Type Cle-Ra-Tone Socket

A socket made with the precision of a jeweled watch. It embodies all of the wonderful shock absorbing features and qualities of the regular Cle-Ra-Tone Socket.

The "Push" Type Socket is designed to accommodate the new standard UX "push" type base radio tube. It will also take tubes with the ordinary bases, excepting the UV-199.

Sold through Radio Jobbers and Dealers everywhere

Benjamin Electric Mfg. Co.

120-128 S. Sangamon Street, Chicago

247 W. 17th Street, New York — 448 Bryant Street, San Francisco

Manufactured in Canada by the Benjamin Electric Mfg. Co. of Canada, Ltd., Toronto, Ontario

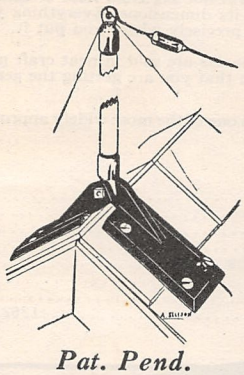
STANDARD ADJUSTABLE AERIAL BASES

Fits any pitch of roof.

Eliminates unsightly aerial.

No wind resistance.

Fitted for ½" or ¾" Standard Water Pipe.



Pat. Pend.

Absolutely protects your building from lightning.

Lasts a life time.

Will not blow down.

PRICE $2.00 at your dealer's or sent postpaid upon receipt of money order.

Insist on your aerial being installed with these new Standard Aerial Bases. Get the best and the cheapest at the same time.

STANDARD AERIAL BASE CO., 227 W. 2nd St., POMONA, CALIF.

Get a Handy Binder for your RADIO NEWS. Holds and preserves six issues, each of which can be inserted or removed at will. Price 65c. Experimenter Pub. Co., Inc., Book Dept., 53 Park Place, N. Y.

(c) To publish an *Internacia Radio Revuo,* which, *inter alia,* by means of Esperanto summaries of original articles from various languages, will place at the disposal of its readers technical documents hitherto only obtainable or to be understood with great difficulty.

4. To co-operate with radio and other bodies, national or international, in improving the status of radio users, and to assist such bodies in every way possible, within its competence.

The International Radio Association already has a large membership, spread through more than thirty countries. The International Secretary is Mr. Harry A. Epton, 17 Chatsworth Road, London, 5 E. United States secretary, J. D. Sayers, Box 223, City Hall Station, New York City; Canadian, C. C. McFarquhar, 163 University Avenue, Toronto. Annual dues, including bulletins, 25 cents.

Today millions are hearing Esperanto "on the air" as the following list shows:

The Hours given are according to Greenwich Mean Time, and, in respect to certain stations, vary from time to time.

AUSTRIA

Vienna (Ravag Wien)—(530 m.).
Esperanto Lesson—Tuesday, 7 p.m.
Thursday, 7 p.m.

DENMARK

Copenhagen (Ryvang, 1150 m, or Kjobenhavns Radiofonistation, 308 m.).
Esperanto News—Monday, 8.30 p.m.

FRANCE

Lyons (Radio Lyon)—(280 m.).
Esperanto Lesson—Tuesday, 10 p.m.
Paris—Ecole Sup. des Postes (PTT)—(458 m.).
Esperanto Lesson—Thursday, 8.30 p.m.
Paris—Radio-Paris (CFR)—(1750 m.).
Esperanto Lesson—Sunday, 8.15 p.m.
Esperanto Talk—Thursday, 8.15 p.m.

GERMANY

Berlin (Vox Haus)—(505 m.).
Esperanto Lesson—Saturday, 7.30 p.m.
Braunschweig (Experimental Station)—(255 m.).
Talks in Esperanto—Wednesday, 6.45 p.m.
Humorous Items in Esperanto—Friday, 11.30 p.m.
Bremen—(279 m.)—Relays Hamburg.
Braslau—(418 m.).—Esperanto 10 minutes—Wednesday night.
Cassel—(288 m.)—Relays Frankfort-on-Main.
Dortmund—(275 m.)—Relays Munster.
Elberfeld—(267 m.)—Relays Munster.
Frankfort-on-Main—(470 m.).
Esperanto Lesson—Friday, 7.15 p.m.
Hamburg—(395 m.).
Esperanto "10 minutes"—Sunday, 3.15 p.m.
Hanover—(296 m.)—Relays Hamburg.
Koenigswusterhausen—(LP—1300 m.).
Esperanto Programme—Sunday, 12.10 p.m.
Munich—(485 m.).
Esperanto Lesson—Thursday, 10.20 p.m.
Munster—(410 m.).
Esperanto Lesson—Thursday, 7.15 p.m.
Nuremberg—(340 m.)—Relays Munich.

ITALY

Rome (URI)—(425 m.).
Esperanto Lesson—Monday, 9 p.m.

RUSSIA (U.S.S.R.)

Moscow (Radio-Popov ex-Sokolniki Station)—(1010 m.).
Esperanto Lesson—Monday, 6 p.m.
Esperanto Lesson—Friday, 6 p.m.

SPAIN

Barcelona (EAJI)—(325 m.).
Esperanto Lesson—Wednesday, 9 p.m.
Bilbao (Radio Club de Vizcaya)—(415 m.).
Weekly Talk on Esperanto.
Madrid (Union Radio)—(430 m.).
Esperanto Lesson—Monday, 9.30 p.m.
Madrid (Radio Iberica)—(392 m.)
Esperanto Lesson—Wednesday, 7.30 p.m.

SWITZERLAND

Geneva (Radio-Geneve)—(1500 m.).
News and announcements to be made daily in Esperanto. Station now testing.

AMERICA (U.S.A.)

New York ("Radio News" Station, WRNY)—(258 m.).
Esperanto Lesson—1 a.m., 24th.

URUGUAY

Montevideo ("General Electric" Station).
Esperanto Lesson—Weekly.

AUSTRALASIA

Gisborne, Poverty Bay (N.Z.)—Station 2YM.
Half-hour Address and Lesson—Thursday, 8 p.m.

TONE

—clear
—natural
—pleasing
—musical

YOU hear *all* the concert with a Bristol. The latest Bristol refinement, the *Super Unit,* contains a large, low-pitch diaphragm, which brings in, not only the middle and upper registers, but all those deep bass notes heretofore only imperfectly heard, if at all.

The rumble of drums, the low pipes of the organ, the bottom notes of the tubas, and the final "Beware" of the basso—those tones which are the very foundation of music—are distinguished in their proper qualities in all selections heard over a Bristol Loud Speaker.

SUPER S $25.00

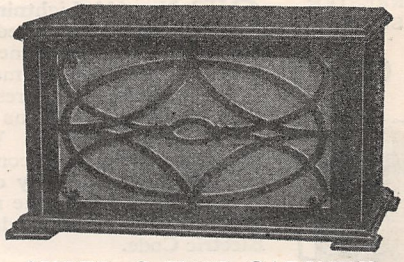
Rubber horn 14½" in diameter. Black mat finish with gold decorated base. Equipped with Super Unit.

Have Your Dealer Send One Out on Christmas Eve

HE WILL be glad to have you try any one of the Bristol Speakers in your home. This is an ideal way to get acquainted with Bristol tone quality and to judge for yourself. There are two models besides those pictured: Model J and the Baby Grand horn types at $15 and $20.

Send for Free Booklet

entitled "How To Select Your Loud Speaker." This booklet is easily understood and explains in detail the "how" and "why" of the many mechanisms and materials entering into various loud speakers. It is very instructive to anyone interested in radio.



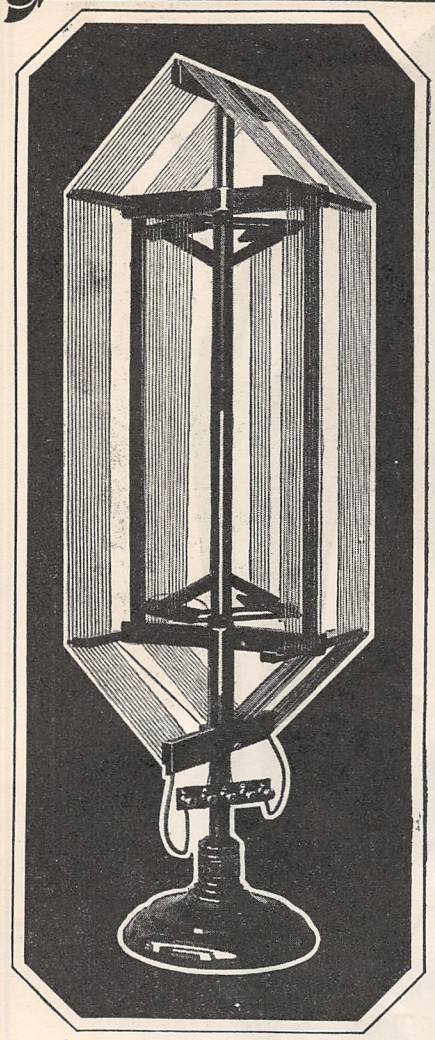
SUPER C THE CABINET $30.00

A handsome addition to any furnishings. Genuine mahogany, size 17 x 10 x 10¾. Equipped with extra long sound chambers and the new Super Unit.

Bristol TRADE MARK AUDIOPHONE REG U.S. PAT. OFF Loud Speaker

THE BRISTOL COMPANY Radio Div. S Waterbury, Conn.

FOR 36 YEARS Ask Any Technical Engineer MAKERS OF BRISTOL'S RECORDING INSTRUMENTS



Beautifully finished in mahogany
Dimensions 30 in. x 8 x 7 in.

Which shall it be?

Just a Loop—or—

AERO-LOOP

If you are "choosey," if you demand real radio reception and maximum results from your set—then the question is answered.

Make your set 100% efficient by using the "Loop-within-a-Loop."

The inner loop is stationary, acting as a booster, while the outer loop is adjusted by rotation.

Used with—or to replace—outside antennae.

Ask your dealer. If he does not carry it yet, we will ship direct, express prepaid, on receipt of price. Be sure to specify the set with which it is to be used and please give dealer's name.

Sells for

$12.50

Write now for Descriptive and Diagrammatic Booklet. Your Copy Mailed Free

SCOTT SALES COMPANY

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443 South San Pedro St.
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Utt-Williams Electrical Products Co.
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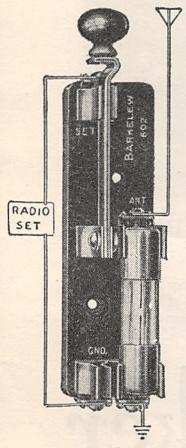
QUALITY PRODUCTS

BARKELEW Lightning Arresters

LIGHTNING ARRESTER SWITCH



No. 602 Price $2.50

OUR No. 602 Lightning Arrester Switch is universally recognized as the only device on the market which combines on one base all those functions essential for maximum protection.

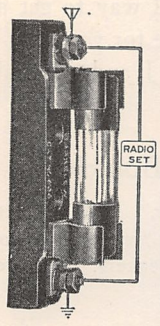
The Vacuum tube arrester is permanently in the circuit from antenna to ground, ready to "spill" any overcharge. With the switch blade the antenna may be disconnected from the radio set and thrown directly on ground.

It meets not only the requirements but also the additional recommendations of the National Electric Code.

Our No. 606 Vacuum Tube Lightning Arrester is less expensive but it meets all the actual requirements of the National Electric Code.

Both are Approved by the Underwriters' Laboratories.

LIGHTNING ARRESTER *Vacuum Tube Type*



No 606 Price $1.50

See our Radio Catalog at your Dealer. If he hasn't his copy, we have one for him.

The Barkelew Electric Mfg., Co.
Middletown, Ohio, U. S. A.

NEW YORK, 157 Chambers St.
BOSTON, 31 Bedford St.
WASHINGTON, D. C., Mills Bldg.
ATLANTA, GA., 180 Spring St.
CHICAGO, 15 S. Clinton St.
DENVER, Denham Bldg.
MINNEAPOLIS, 1017 Lumber Ex.
SEATTLE, 1041 Sixth Ave. S.
SAN FRANCISCO, 75 Fremont St.
LOS ANGELES, 443 S. San Pedro St.
TORONTO, 20 Bloor St., W.
MONTREAL, 296 St. Paul St. W.

Third National Amateur Convention

(*Continued from page* 993)

around the main streets and we were at the hotel enjoying a well-earned rest, going to sleep early that night in order to be QRV for the opening of the convention the next day.

Tuesday saw the amateurs flocking to Chicago in flivvers, autos and other means of transportation. (One bunch of fellows drove in on an ice wagon.) We must say, however, that most of the gang came in flivvers, all decorated for the occasion, having their call letters on the *car* and other signs, such as "front door for employees, rear door for customers," "Four wheels, no brakes"; "Show us the town girls"; etc. Not to be outdone, we had a sign on APV's car which read "QST—QRX—QRT—for hard-boiled hams from New York."

The day was given over to registration, meeting old friends and making new ones. We were greeted by amateurs from every district and Canada.

THE ROYAL FEAST

The banquet was held in the evening and the Second District Executive Radio Council could well take the example set, inasmuch as the banquet started at 7:30 sharp and was over by 10:30 P. M., including eats, drinks and speeches. (Those who have attended the annual conventions of the Executive Radio Council, Second District, will recall the wee hours of the morning when the affair began to wind up.)

We ten fellows from New York were lucky enough to get a table in front of the speaker's table, the writer using considerable influence—political and otherwise—in procuring it. Unlike many banquets, the food was good and the speeches were to the point. Some of the speakers were Bill Schweitzer, 9AAW, the chairman; Mr. Davis, Vice-President of the Chicago Traffic Association; Major Frost, of Frost Phone fame; Mr. Dawes, brother of the Vice-President of the United States; Mr. Kruse, Mr. Hebert and Mr. Warner of the A. R. R. L. After the banquet, the amateurs dispersed, going to different rooms, where post-banquet parties were held, while others embarked for visits to local stations. Few, if any, went directly to sleep. In our room, which was packed with amateurs from all parts of the country, the portable transmitter and receiver were pressed into service. We worked several stations and succeeded in hearing numerous amateurs on both coasts.

A casual glance at the door of our room revealed the fact that our room number was no longer visible, every visitor leaving his card and call letters plastered over it. We could not have received a greater variety of cards had we received them as QSLs!

THE WILD AND WOOLLY WEST

The next day, Wednesday, was given over to auto tours to broadcast stations and visiting the "rodeo." As we were supposed to be in the wild and woolly West, APV, 2FZ and yours truly visited the rodeo and we saw cowboys and Indians, apparently doing nothing but chasing a few cows all over the lot. After said cow got tired of running, she was lassoed and led off the field in triumph. This sort of thing was not exciting to us New Yorkers, and since no one was killed, nor were there any bullfights, we were sorry that we didn't go with the others to visit WHT at Deerfield, Ill.

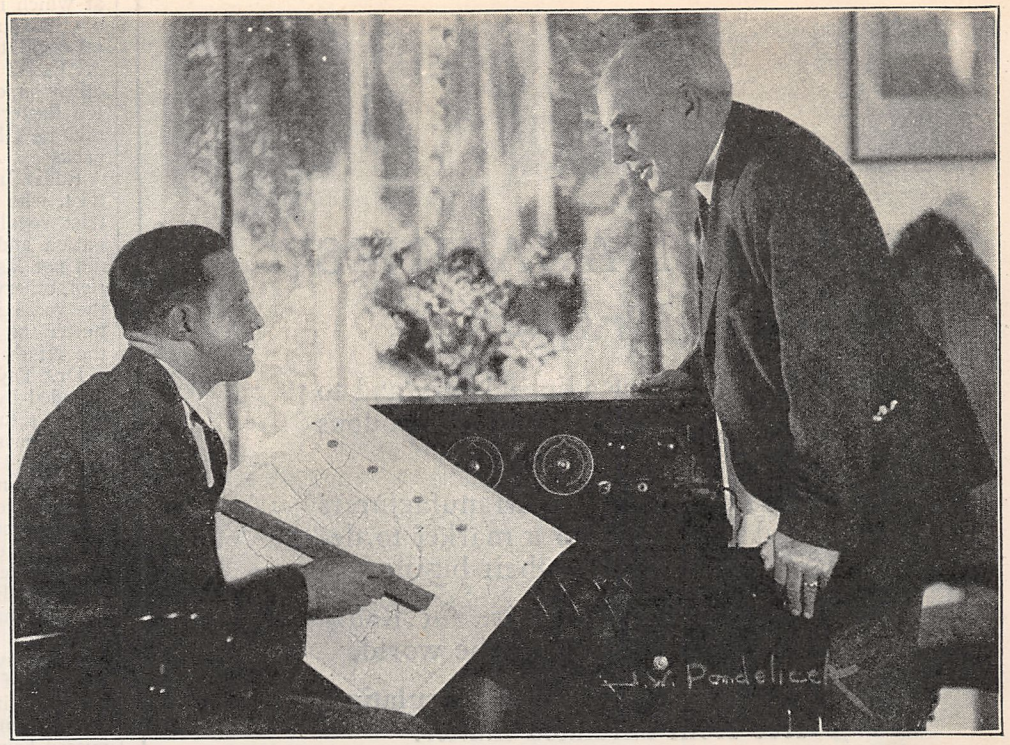
TECHNICAL DISCUSSIONS

In the evening there ensued a technical meeting on receivers, at which prominent amateurs and radio engineers spoke, but since we had some very important *business* to transact we were unable to attend!

On Thursday, transmitters were discussed,

Valley Tone

Radio Receiver



The Valleytone multiplies the pleasures of Radio

From the corners of the continent or from the stations of your city, the realm of radio is yours to conquer. . .

Out of the boundless ether, borne on the wings of night, comes program after program for your pleasure. . .

Set the stage for endless entertainment by making your radio a Valleytone Radio Receiving Set. For you can truly count on the Valleytone to multiply the pleasures of radio.

Your ability to choose your programs is greater with the Valleytone, because selectivity is greater in the Valleytone. The Valleytone easily and regularly separates stations only four or five meters apart.

And your enjoyment of the programs you select is keener because Valleytone programs are clear and natural. The Valleytone inspires genuine amazement at its tonal quality. Employing the exclusive *potential balance*, it reproduces with a faithful, balanced tone which is equalled by no other radio.

The Valleytone welcomes critical demonstrations. It thrives on comparisons. For, wherever it is judged by results and on performance, it wins a new buyer.

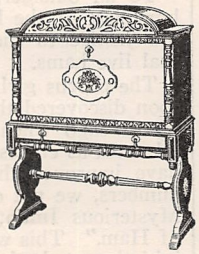
Any dealer will be glad to show you the Valleytone.

VALLEY ELECTRIC COMPANY, *Radio Division*, ST. LOUIS, U.S.A.

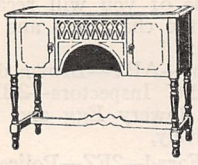
Branches in Principal Cities

Appearance

The Valleytone is mounted in a solid walnut cabinet, finished in two tones with inlaid gold stripes. It may also be procured in beautiful console models. Special Valley tables will built-in loud speaker may be obtained for the cabinet model.



Valleytone Console Model No. 35



Valley table with built-in loud speaker

Valleytone Receiving Sets | **Valley Battery Chargers** | **Valley B-Eliminators**

Valley Electric

RMPA

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Always First—

First to foster the Radio industry and to make possible its tremendous growth.

First to furnish Radio Manufacturers and Dealers with a market to develop and expand their business.

First to introduce the desire for Radio in homes throughout the world.

First in 100% purely Radio circulation, free from unrelated matter.

First to publish the newest ideas in Radio to those who want the newest in Radio.

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First in Radio advertising lineage.

RADIO MAGAZINE PUBLISHERS ASSOCIATION, Inc.

98 Park Place New York, N. Y.

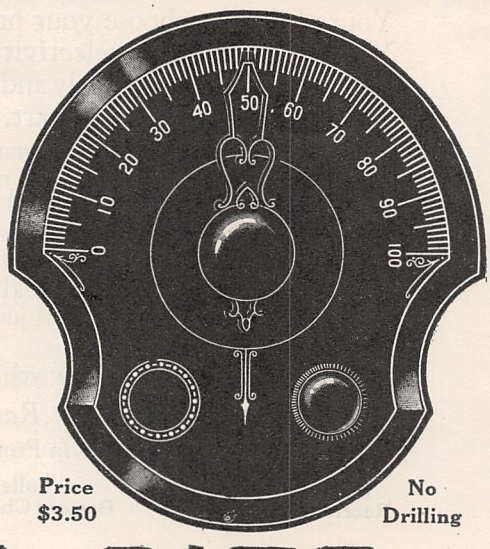
Separates Those Crowded Stations

No matter how crowded the low wave stations, they are easy to get, clear, perfect in tone. All accomplished with this beautiful dial. So scientifically thought out that it's really a revelation in tuning. Gives your present set every advantage of the straight line frequency receiver, but without the necessity and expense of rewiring. Gradually changing ratios from 24 to 1 at low wave lengths to 2 2/3 to 1 at high wave lengths does the trick. **Instantly attached to any set.**

Convert your set to straight line frequency. Send for instructions.

Radiall Company

Dept. T.R.N.-3, 50 Franklin St., New York



Price $3.50

No Drilling

TUNE-RITE
The Straight Line Frequency Dial

Made by the makers of Amperite, the Self-Adjusting Rheostat

at which meeting Dr. Taylor of the Bureau of Standards spoke and described the crystal oscillator at NKF, etc. Again, we three, APV, FZ and PF, had to leave, due to another important business meeting. UD was too flustered to meet any of the YLs, so he told us all about transmitters when we got back.

Radio Inspector Beane, of the Ninth District, who was formerly of the Second District, royally entertained the New York delegation and it was too bad that the supply did not last longer—the supply of *information,* otherwise called ginger ale. Incidentally, the radio inspector gave the portable transmitter the call 9EUD while it was in use in the Ninth District.

Dr. Taylor was still going strong, surrounded by a bunch of amateurs, when the writer returned at 1 A. M. We then entered the discussion with full vigor and it was not until 4 G. M. that we got to sleep.

Friday morning was the time set for the athletic events. The tug of war between the "High" and "Low" power stations was won by the latter. (If you saw some of the husky 200-pounders who operate 5-watt stations you wouldn't wonder.)

No swimming contests were held, as it was too cold.

The convention picture was taken at noon in front of the hotel, but due to our "Broadway" habit of eating breakfast and lunch at the same time—thus saving money—we missed being in the picture. Not to be outdone, however, 2FZ unloaded his big Graflex and took a shot at the gang.

In the afternoon there was a technical meeting on transmitting and, after lengthy discussions by many well-known and leading amateurs, the meeting closed early to enable the amateurs to prepare for the big night.

"A GOOD TIME WAS HAD BY ALL"

The grand finale was held Friday night in the open air gardens of the Rendezvous Cabaret, one of the best in Chicago. Words cannot express the splendid feeling of good-fellowship that evening. Our recollection of the events as they transpired is a trifle hazy, but an attempt will be made to outline them briefly.

A bounteous chicken dinner was served and was dispatched amidst the clatter of bottles and glasses. The Second District fellows were there with the goods—they cleaned the plates with the least fuss and in the quickest time.

To an outsider, they appeared to be the hungriest of the large assemblage, and they did justice to their ability and renown as real live hams.

The chorus girls appeared next and it was soon discovered that New York has nothing on Chicago when it comes to revues. We all acted as critics and daresay that we could have improved the situation. After a few numbers, we put over our stunt called "The Mysterious Initiation Into the Royal Order of Ham." This was similar to the "ERCO" initiation at the last Second District convention, which some of you will recall. The following were the characters and the costumes they wore:

Radio Inspector—APV—Brown derby.

Assistant Radio Inspectors—2BNL and C3MN—Tough Bowery Egg and Sherlock Holmes, respectively.

Micro-Micro-Farad—2FZ—Policeman.
Micro-Micro-Henri—2UD—Hangman.
Power Amplifier—9AZK—White Robe.
Lead-In—9IX—Cowboy.
Master of Ceremonies—2PF.

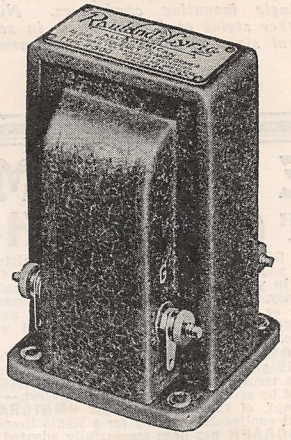
It so happened that the unfortunate candidate was 3GC, from Philly, though 6ALF was the first candidate chosen, but seeing Sherlock Holmes coming for him, started back to California. 4KL, the next candidate, hid himself under a table, so poor 3GC had to be sacrificed. Those of you who saw the "ERCO" initiation know what happened and

Rauland-Lyric

ALL-AMERICAN
TRADE MARK
AUDIO FREQUENCY TRANSFORMER
TYPE R-500 SERIAL Nº
ALL-AMERICAN RADIO CORP. CHICAGO, U.S.A.

When a Finer Transformer Is Made It Will Bear This Name-Plate

Radio moves rapidly. Perhaps some time there may be seen a *better* transformer than what we *now* know as Rauland-Lyric. It may sell at $9, or $10, or $15, or $7. But the careful observer of the past year's developments will entertain not a moment's doubt of one thing: when the better transformer comes it will come beneath the famous Rauland-Lyric name-plate. Behind this as a pledge rests the entire organization and resources of the All-American Radio Corporation



Rauland-Lyric is easily obtainable from better-class dealers everywhere. The price is nine dollars. Descriptive circular with technical data may be had on request to All-American Radio Corporation, 4201 Belmont Avenue, Chicago

Rauland-Lyric tone quality is now available in a complete receiver: the new All-American Model R (a five-tube tuned-radio-frequency set) now being shown. If your preferred dealer does not display it, send to us for descriptive booklet

The double advantage of RADION

Radion Panels in black and Mahoganite come cut in all standard sizes.

Successful set manufacturers and experienced amateurs know that there are two important requirements for any set:

1. Efficient reception—a matter of quality parts, skillful assembly and correct design.
2. Good appearance—evidenced in the attractiveness of the cabinet and panels.

THE selection of RADION goes far toward fulfilling both these requirements. RADION Panels possess superior insulating qualities not equalled in any other panel made. And RADION has such a beautiful surface finish that it noticeably enhances the appearance of any set.

This double advantage of RADION is due to the fact that it is the only insulation that was made to order for radio purposes exclusively.

The high-resistant characteristics of RADION Panels mark all RADION low-loss parts—Sockets, Dials, Insulators, Tubing, etc. Adopted by many leading manufacturers and sold universally by radio dealers.

Send for booklet, "Building Your Own Set." Mailed for 10 cents.

Manufacturers—Our facilities and equipment for the manufacture of molded parts are second to none. Write us for prices on quantities.

AMERICAN HARD RUBBER COMPANY
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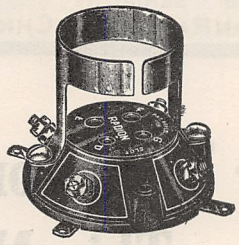
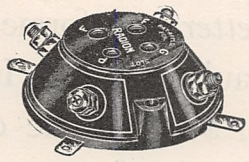
Chicago Office: Conway Building
Pacific Coast Agent: Goodyear Rubber Co., San Francisco—Portland

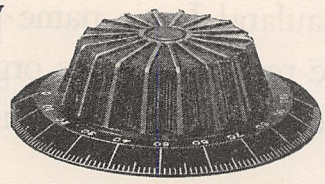
RADION
The Supreme Insulation
made to order for radio purposes exclusively



No. 2 Radion Socket for new UX tubes, with collar adapter for old type tubes.

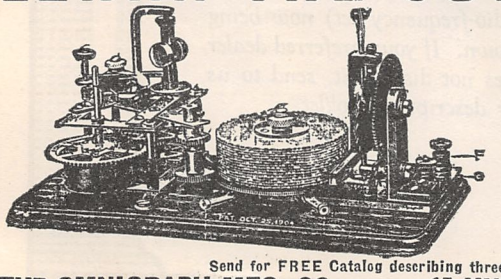


No. 4 Radion Socket for new UX tubes exclusively.



New No. 10 4-inch Radion Dial, built to conform to the fingers, helping you to get close tuning. May be used for single mounting condensers. Nine other styles of Radion Dials in several sizes to meet all requirements.

LEARN THE CODE AT HOME



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THE **OMNIGRAPH** Automatic Transmitter will teach you both the Wireless and Morse Codes—**right in your own home**—quickly, easily and inexpensively. Connected with Buzzer, Buzzer and Phone or to Sounder, it will send you unlimited messages, at any speed, from 5 to 50 words a minute.

THE **OMNIGRAPH** is not an experiment. For more than 15 years, it has been sold all over the world with a money back guarantee. The **OMNIGRAPH** is used by several Depts. of the U.S. Govt.—in fact, the Dept. of Commerce uses the **OMNIGRAPH** to test all applicants applying for a Radio license. The **OMNIGRAPH** has been successfully adopted by the leading Universities, Colleges and Radio Schools.

Send for FREE Catalog describing three models. DO IT TODAY.

THE OMNIGRAPH MFG. CO., 15 HUDSON STREET, NEW YORK CITY

If you own a Radio Phone set and don't know the code—you are missing most of the fun

Insure your copy reaching you each month. Subscribe to Radio News—$2.50 a year. Experimenter Publishing Co., 53 Park Place, N. Y. C.

those of you who did not, missed the time of your lives.

After our initiation, there was another act, this, too, was very interesting, but it is left to the imagination to portray what took place.

The Milwaukee Radio Association put over their initiation, called "The Royal Order of the Derby." This was very solemn and was well acted. The scenery and costumes were splendid and the initiation was similar to the "R.O.W.H." Too much credit cannot be given to the Milwaukee club for putting it over in such fine style.

After the usual amount of hilarity, a lottery was held, and the writer won a Burgess "B" battery, which he highly prizes. 9AAW closed the convention with a few words and the amateurs left for home.

Thus ended the Third National A.R.R.L. Convention, which was a real ham convention from start to finish, and if you have never been to such an affair you have been missing the time of your life!

The Radio Beginner

(*Continued from page* 991)

explained in all its phases, but such is not the case. As yet it is not actually known why a crystal detector acts as a rectifier. There are, however, two distinct theories that may be considered, both of which hold some merit. We shall give both of them here but cannot state which one is correct.

The first of these theories is what is known as the electrolytic action theory. It must be conceded that at all times there is a certain amount of moisture present in the atmosphere and, of course, there is a like amount on the surface of the crystal. The theory goes on to say that an electrolytic action may take place between the cat-whisker or other contact and the surface of the crystal. In other words, this point might be likened to a very small battery. This little battery sets up a current that flows in only one direcion when connected in a circuit. When the minute radio currents start to come into the detector and flow in one direction and then in the other, they are assisted by this direct current generated by the detector when they are flowing in the same direction as that current, but when the radio frequency current reverses its direction, it is bucked or resisted by the detector current and, therefore, cannot flow or at least is so far reduced in strength as to be practically negligible. In other words, we might say that the current generated by the detector, if this theory is to be accepted, first aids and then resists the radio frequency current, giving rise to an action such as that heretofore described. This would account for the fact that a crystal of certain type allows radio frequency current to flow through it in one direction but not in the other.

The other theory which attempts to account for this peculiar action is known as the heat theory. We all know or can easily find confirmation of the fact that when two dissimilar metals or electrical conductors are in contact and connected in a circuit, and the point of contact is heated to a temperature greater than that of the rest of the circuit, a current of electricity will be caused to flow in one direction only. We can then consider the point of contact between the cat-whisker and the crystal as indicated in Fig. 8 as being the point mentioned and that the radio frequency current flowing through the detector sets up heat. This heat in turn causes a current to be generated at the point of contact between the cat-whisker and the crystal and this current flowing in only one

Where the Future of Radio Lies

A Finer Musical Tone Obtained by a More Perfect Reproduction of the Overtones

Single Dial Tuning Which Is Absolutely Free from Verniers or other Auxiliary Adjusters

Actual Wave Length GLOWS from Illuminated Disc—No Scale Necessary

THE time is coming soon, is here now, when radio receivers will be bought like pianos for the quality of their tone and for ease of operation. All other considerations are minor.

Last year radio advertising was full of claims for distance, volume and selectivity. This year the emphasis is upon tone quality and single dial tuning. Makers realize that these are the things people want, that this is the direction in which progress must be made.

Simplicity—Not Complications

These two needs are fundamental and they must be *fundamentally* met. Superficial makeshifts merely complicate. You cannot get anywhere by attempting to improve radio tone by "trapping" stray energy coupling between circuits; you may thus neutralize unpleasant noises; but you still have the "traps" and the coupling and their hampering effect upon the flow of delicate vibrations which make overtones. The very presence of such neutralizing devices is evidence of error.

Perfect "Overtone" Reproduction

The whole secret of Pfanstiehl tone is just here: There is no possibility of stray energy coupling; no "traps" are required. The reproduction of overtones is perfect because the pattern of vibrations is kept intact, unblurred and unmarred by inequalities in the circuit. Hence the tone is supremely beautiful.

Absolutely SINGLE *Dial Control*

Hence, also, the single dial control is absolutely SINGLE. No verniers or auxiliary adjusters are needed to refine or complete the tuning. The one dial works perfectly, tunes completely for any distance, because all three circuits are exactly alike; there are no *electrical* differences to overcome.

For further details, address

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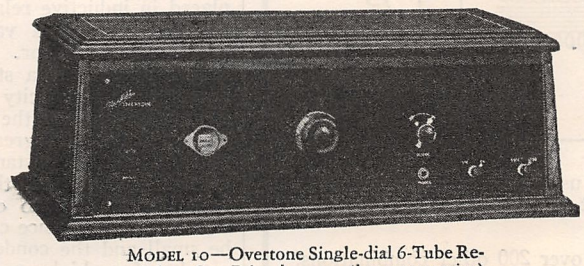
Prices West of the Rockies Slightly Higher

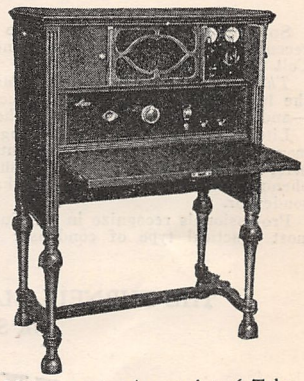


MODEL 10—Overtone Single-dial 6-Tube Receiving Set. Price $155.00 (less accessories)

Pfanstiehl

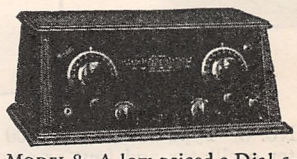
"OVERTONE" RECEIVER

Perfectly Reproducing the Overtones



MODEL 10C—A complete 6-Tube Single-dial Console Overtone Receiver with Overtone Speaker, Control Board, Battery Charger and Compartments for Battery built in. Price $450.00 (less tubes and batteries).

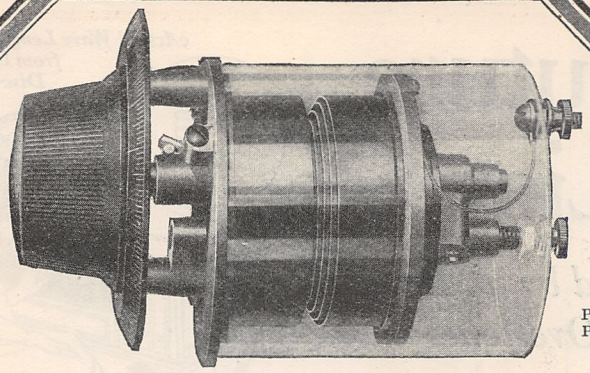
MODEL 10S—Overtone Single-dial 6-Tube Receiving Set with demountable Console Stand. Overtone Speaker built in. Price $200.00 (less tubes and batteries).



MODEL 8—A low priced 2-Dial 5-Tube Receiving Set, Pfanstiehl quality throughout. Price $85.00 (less accessories).

An Exclusive Dealer Franchise

The Pfanstiehl line is sold through exclusive dealers who are thus protected against unfair competition and price cutting. Whatever good-will the dealer builds up for Pfanstiehl is his own. He enjoys a liberal profit and is expected in return to push the line aggressively with the cooperation of the maker.



PATENTS PENDING

"The Most Practical SLF Condenser I've Seen"

So commented a prominent radio engineer recently, after testing the new Furnell Taper Coil Condenser.

The Furnell stands absolutely alone. It is the first radical improvement in condensers —and the only one of its type on the market.

Literally thousands—including "fans," manufacturers, engineers, distributors, jobbers, dealers, etc.—have been showing a phenomenal interest in this remarkable new condenser.

Professionals recognize in the Furnell the most practical type of condenser ever designed for Straightline Frequency tuning. It affords a wonderful smoothness of operation and assures a clean-cut separation of all stations, regardless of wavelength.

And the strong, transparent Pyralin shield keeps the Furnell absolutely dust-proof, moisture-proof, and damage-proof, insuring permanent accuracy and precision. Made in three capacities—single and multiple.

Exclusive sales franchises are available to reputable jobbers in locations still open. Particulars on request.

Write for Literature

THE FURNELL MANUFACTURING CORPORATION
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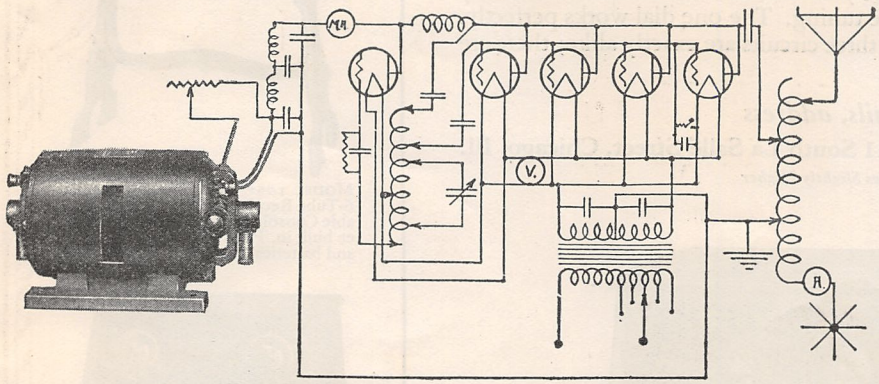
FURNELL
360° TAPER COIL
CONDENSERS



Item No. 8 Type M. G. 113 500 volts 150 watts when used with one five watter as a master oscillator and four as amplifiers, will make a set of which the owner may be justly proud. A real DX getter.

Or if this set does not suit there is Bulletin 237B listing over 200 other combinations. Write for your copy today.

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Manufacturers of Motors, Generators, Motor-Generators and Dynamotors.

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direction, acts to buck or assist the radio frequency current in much the same way as explained under the electrolytic theory. And there are the facts of the two theories, propounded by various radio experts to explain the action of a crystal detector. We will not state here which one of them can be accepted as they are both plausible. To the writer, the heat theory is the most acceptable, particularly so when it has been definitely proven that under certain conditions a slight increasing of the temperature of the crystal detector will affect the signal strength and make it greater. If you are interested in trying this experiment, do it very carefully, as excessive heat will often destroy the sensitivity of the detector. Sometimes increasing the temperature of the detector itself from ordinary room temperature to about 110° will bring about a remarkable change in signal strength.

To a good many people, a crystal detector is merely a crystal detector and can be used in any old circuit or with any junk instruments that may be on hand. They do not realize that the crystal detector is a real radio instrument and that, when treated as such, it will deliver some exceptional results. It is not wise to place a detector in a circuit with any arbitrary size of variable condenser and inductance that may be on hand and expect it to work well. There are certain fundamental principles that must be followed if one would achieve the best results. In general, crystal detectors can be divided into two classes. The first class is those having a low resistance such as galena, bornite, radiocite and synthetic minerals of a similar type. The other class is the high resistance type and the most common crystals to come under this head are carborundum and pericon. Now it is obvious that with a different resistance crystal the results obtained in a radio receiving set will differ. Particularly is this true in regard to the voltage impressed on the crystal detector, but inasmuch as the underlying theory of this is rather complicated, we shall not attempt to deal with it here. However, let us refer to the circuit shown in Fig. 9 and explain just how the best results can be obtained with either a high or low resistance crystal. In either case, the tuned antenna circuit represented by L and L1 in the diagram will be the same. The two coils should be of sufficient size to cover the entire broadcast range with the particular antenna that is being used. In general, for the average size of aerial, about 100 feet long over all, use 35 turns on a 3-inch tube for L and 10 turns on a 3-inch tube for L1. Coil L should be tapped so as to give quite fine variations of adjustments. Coil L1 is not tapped and is placed so that its axis is at right angles to that of L. Coil L2 is placed in inductive relation to L1 and might be the rotor of a variocoupler, L1 being wound on the stator. C is the tuning condenser and C1 is a standard blocking condenser with a capacity of about .001 mf. It is in the design of the coil L2 and the condenser C that the greatest efficiency can be realized. If, for instance, a high resistance crystal is employed, the coil L2 should be large in relation to condenser C, whereas with a low resistance crystal, the coil should be small and the condenser large. In other words, for high resistance crystals, L2 should have about 45 turns of wire and C should have a capacity of .0005 mf. For a low resistance crystal, L2 should be wound with about 25 turns and condenser C should have a capacity of .001 mf. In this way the best results with the two different types of detectors mentioned will be obtained.

The thoughts and facts given in the above article should help the experimenter as well as the beginner, for as the era of super power for broadcast stations comes closer and closer, the crystal is sure to regain its old importance.

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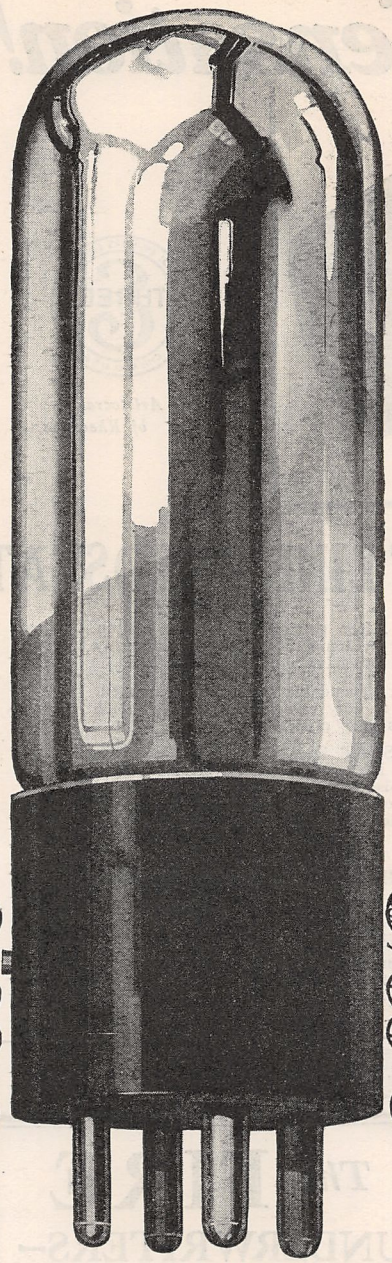

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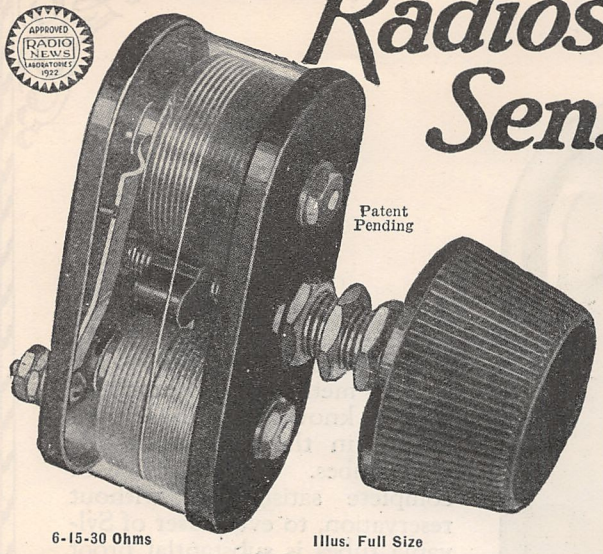

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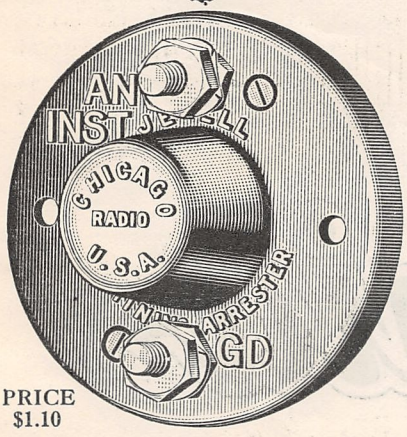

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Super-Regeneration and the Future

(*Continued from page* 977)

USE OF THE DOUBLE GRID TUBE

The thought came, "Why not vary the potential on the grid by varying the electron stream that reaches the grid?" The most practical way that suggested itself is shown in Fig. 2. This calls for a double grid tube. The oscillator function is carried out between the inner grid and the plate, alternately letting by and shutting off the stream of electrons, and thus controlling the outer grid in a manner similar to that of Fig. 1, but without the disadvantages of the shunt system directly connected in. Here the shunt is coupled only by the very small grid-to-grid capacitance. The circuit tuned to the incoming signal has its own separate grid and can be tuned as sharply as is desired. The two-plate circuits, by various capacitance and inductance chokes, are made to function independently. And the problem seems to be solved!

Unfortunately, the difficulty of getting a tube suited to the specific uses of this circuit has precluded the possibility of a really fair test. A makeshift was made up from a VT-2 with an extra grid inserted. The tube was not very satisfactory, which may have been due to the difficulty in exhausting the gases to the right pressure with the mercury pump at hand. It would, however, function fairly well in conventional circuits using either grid with the other free or grounded, and could be made to oscillate feebly at the usual frequencies.

When used in the circuit of Fig. 2, this tube gave the hoped-for results as far as quietness of operation was concerned, and the tuning was admirably sharp. But the signals received were too feeble to allow a fair judgment of the value of the device to be made. When the oscillator was functioning, signals became much louder than when the circuit was used as a conventional loop receiver. This was encouraging.

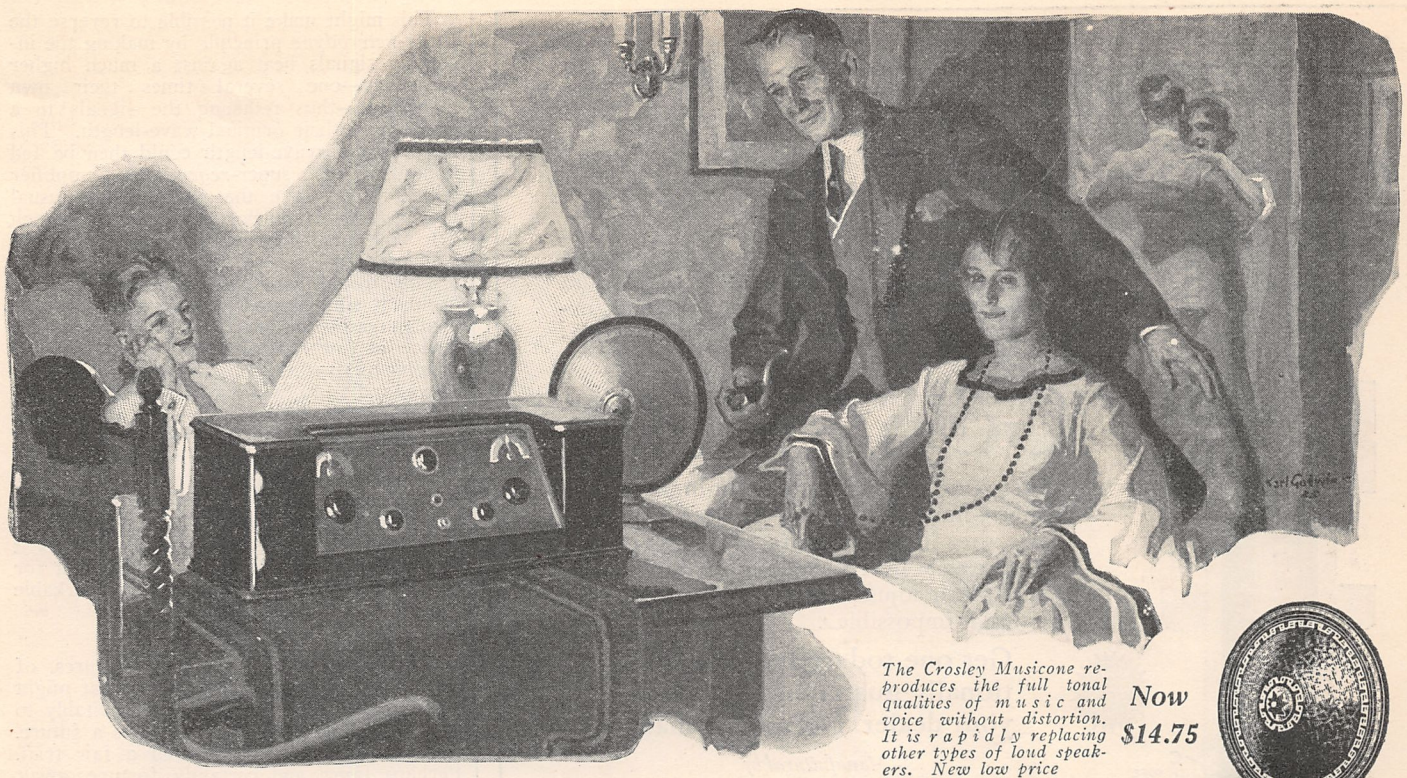
A search was then made for a more suitable tube. A double grid Dutch tube was tried with results only slightly better than those obtained with the rebuilt VT-2. Here the trouble was easily traceable to the rather low power of which the tube was capable, and to the fact that the tube, even in normal use, was a very feeble oscillator.

But in each of the above tests results that can be called positive were achieved. The circuit works. It eliminates the undesired noises. It is capable of the sharpest of tuning, and of considerable range. Whether or not it is commercially practical must remain a question until more suitable tubes can be procured for a thorough test.

In the meanwhile, the writer wishes to present to the experimenting public the data gathered so far. It may not be that the circuits of Figs. 1 and 2 will even be recognizable as the roots of the complete, practical super-regenerator of the future. But they do represent two steps in advance and, in the writer's opinion, work well enough to justify further study and research. It is the purpose of this article to stimulate such research. A properly designed double grid tube may be all that is needed to make the super-regenerator practical. It may be no more than another step toward the goal.

It is with this in mind that the writer asks the co-operation of any experimenters who have double grid tubes, or who have the facilities for making them.

In closing, it might be well to make notice of another possible use for this device. As is well known, the efficiency of the super-regenerative set increases rapidly as the wavelength is lowered. To be scientific, the amplification at 100 meters is nine times as great as it is at 300 meters, other conditions being the same.



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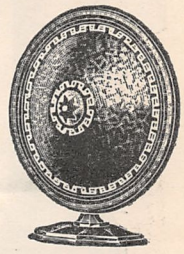

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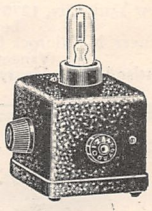

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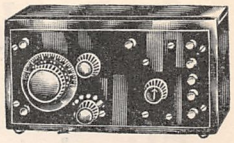

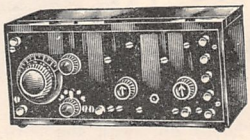

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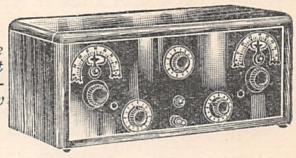

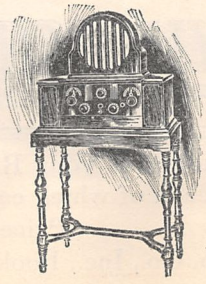

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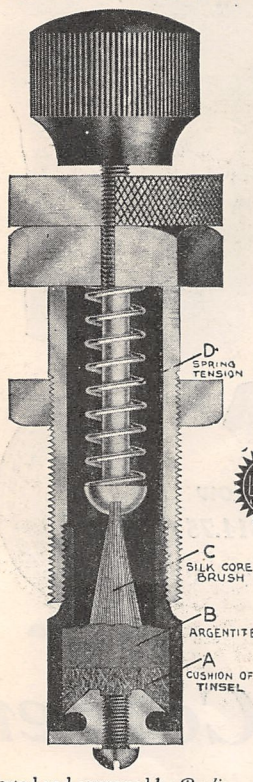

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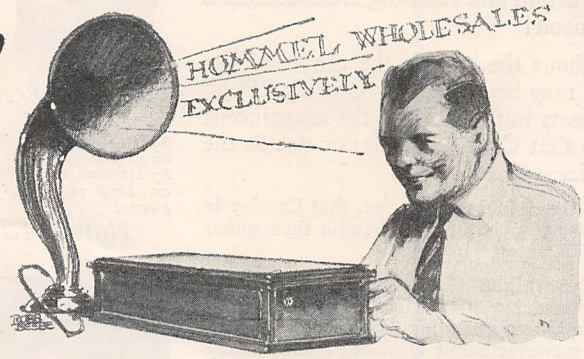

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This might make it possible to reverse the super-*heterodyne* principle by making the incoming signals beat against a much higher frequency—one several times their own magnitude—thus reducing the signals to a fraction of their original wave-length. This new reduced wave-length could then be fed into a one-tube super-*regenerative* amplifier which would take the place of the usual intermediate frequency stages, after which detection could be accomplished in the usual manner.

This would have an advantage over the ordinary, simple super-regenerative arrangement, because the very high efficiency of the device at low wave-lengths would make it possible to use an oscillator frequency well above audibility without impairing the signal strength. This would eliminate entirely one of the undesirable noises.

To the best of the writer's knowledge, super-regeneration has not been tried on the really short waves, where its amplification would be tremendous. The amplification factor at 20 meters is 225 times as great as it is at 300 meters. Here is another field for experimentation. It might yield remarkable results.

CONCLUSION

This review of facts and conjectures, of what has been accomplished and what might be accomplished, seems to point inevitably to one thing. Super-regeneration has a future. As yet, it has not been given a fair trial. Perhaps fame, and certainly fortune, await the first practical super that is placed on the market. For this remarkable circuit, when at last brought under perfect control, will afford a compactness and saving in tubes never before realized. There is no good reason why, with the reversed super-heterodyne described above, three tubes cannot be made to do the work that is now being done by eight. Is that not enough of an argument for a renewal of interest in the circuit?

Lack of capital, and consequent lack of facilities, have hampered the writer in giving a full trial to the theories herein expressed. They are now available to others who may be in a position to perform more exacting experiments. That "position" means, in the main, a double grid tube with an unusually high filament emission.

Hoover Opens Radio Conference

(*Continued from page* 957)

ragua. We have reason to hope that connection with Guatemala will soon be effective, thus forging another link in the communication chain which binds us to our friends in Central America. Direct service with Sweden commenced last December, and other European, South American and trans-Pacific services have continued their effectiveness. Enterprises have been undertaken in the Philippines and in China. Altogether, we shall, by another twelve months, have systematic radio telegraphic communication with nearly every important country in the world—a matter of vast importance, for it increases the movement of ideas as well as business. We have no pressing problems before us in this field.

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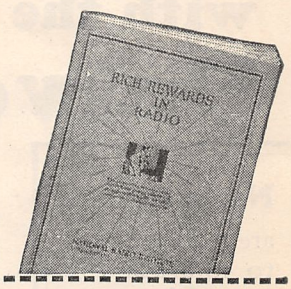

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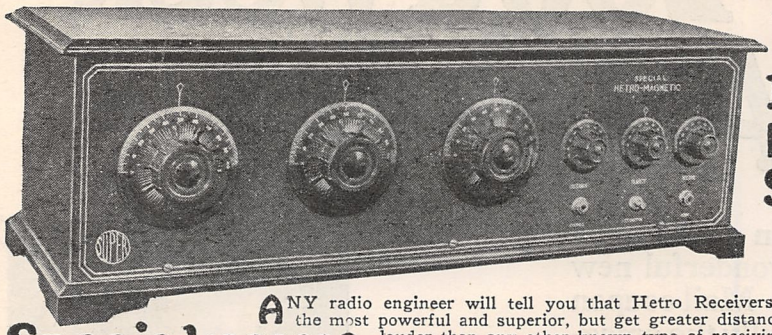

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SPECIFICATIONS

Panel: Bakelite 7 by 26, high polished. Cabinet 29 by 10 by 9, Walnut. Condensers and coils, straight line tuned. Dials: Bakelite. Base Board depth 7 inches.

As predicted the **Hetro Magnetic** Receiver has revolutionized all forms of coil windings in sets. Practically every high priced receiver employs coils as near as possible as to that of the **Hetro**, as near as patent will permit. The parallel field coils have proven to be supreme. It enables to obtain twice the power per tube. **Coast to Coast** reception is guaranteed, although **European** stations have frequently been heard and **hundreds** have made **successful** reports of the latest **trans-oceanic** broadcasting test. Here you have a 5-tube **Hetro Receiver**, world's **most powerful**, the very best and **first prize winner**, wired to give the results of 8. Regardless how much you pay, you **cannot** purchase a better instrument than this one. Works on an indoor or outdoor aerial. Employs the standard 3 dial tuning system, thus securing the same stations at all times on the original numbers. The first three tubes give you 6 stages of amplification. **Three magnetic** coils for each tube or 11 sets of transformer parts. The tone is **truly remarkable** and the most distant station is obtainable with **amazing** clearness on the loud speaker. The fact that the B batteries last from 6 to 8 months with this receiver, whereas the average two, saves the purchaser considerable money. Works on either storage or dry battery and contains expensive bi-pass condensers to **eliminate** unnecessary **noises.** Distant stations are obtainable in broad daylight. Tuning is exceptionally easy and **sharp**, enabling you to **cut through** local stations without difficulty. The **Super Hetro Magnetic** has sufficient **volume** (adjustable) without the use of extra attachments, to be used in ball rooms, schools, churches, etc.

$45.00

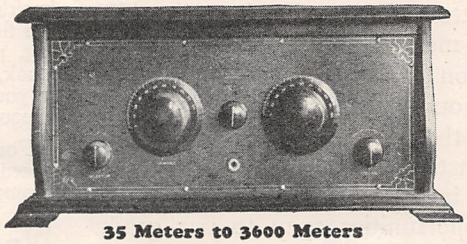
PRICES

Super Hetro Receiver to fit Console	$39.50
Super Hetro Receiver with Cabinet	45.00
Super Hetro Complete with All Accessories and High Grade Loud Speaker	83.50
Super Hetro Receiver Complete Dry Cell Operation	73.50

Console Prices on Request

MERCURY ELECTRIC CO., 2030 Grand Ave., N. Y. C., N. Y.
966 DEXTER HORTON BUILDING SEATTLE, WASH.
85 Boulevard Voltaire, Paris France
Takeshis Yamamoto, 548 Oka Hirakatacho, Osaka Fu, Japan
East India Radio Co., P.O. Box 2087, Calcutta

Hear Europe with the Universal Plio-6



35 Meters to 3600 Meters

No Batteries are required even to operate the powerful receiver pictured above, if you use the new laboratory type **Model A Power Unit**

A new broadcast receiver representing the highest type of efficiency obtainable in point of extreme range, tremendous audibility and remarkable selectivity.

Maximum Efficiency—Inexpensive
Parts or Completely Constructed

Write for information today

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Engineers
1617 Chestnut Street, Philadelphia, Pa.

Insure your copy reaching you each month. Subscribe to Radio News—$2.50 a year
Experimenter Publishing Co., 53 Park Place, N. Y. C.

vessels of those countries will no longer use these troublesome channels in Morse code communication off our coasts. I am hopeful that like understandings may be reached with other nations whose ships visit our shores. A few months ago, we reached an informal agreement with Canada relating to radio use by vessels and shore stations on the Great Lakes, by which 600 meters was abandoned, spark sets discouraged and communications placed on 715 and 875 meters—one more example of the friendly co-operation between ourselves and our northern neighbor, which has always characterized our radio relationships.

The 600-meter wave-length is today used almost exclusively for calling and distress work, there being very little other traffic handled on it. Individual working channels have been assigned to the North Atlantic coastal stations and traffic is handled more readily and with considerably less interference. This plan is being extended to the South Atlantic, Gulf and Pacific stations. It is a very real advance, both in the clearing up of another of the sources of interference with telephone broadcasting and in the introduction of more order into marine communication.

TELEPHONIC RADIO

It is in broadcasting, of course, that we have again seen the most important changes and in which we again develop the most pressing problems. There has been some improvement on the technical side. Better means of enabling the stations to maintain their assigned frequencies have eliminated much beat note interference.

The increase in the frequency range of receiving sets is making the shorter wavelengths of the broadcasting band more available. Improvement in sets has given far greater perfection in tone and quality. Experimental work in the high frequencies is giving encouragement to the further development of the art.

The most profound change during the year, however, has been the tremendous increase in power and the rapid multiplication of powerful stations. When the conference assembled a year ago, there were 115 stations equipped to use 500 watts or more. Now we have 197 such stations, an increase during the year of over 70 per cent. This mere numerical expansion of stations falls far short of telling the whole story. A year ago only two stations were equipped to use an excess of 500 watts. Of the new stations, 32 are equipped to use 1,000 watts, 25 to use 5,000 watts and two a still higher power, making 59 in all against two last year. Taking the situation as a whole, we find that a year ago all stations of 500 watts and over were using a total of 67,500 watts. Today they use 236,500 watts, or a 250 per cent. increase.

A year ago, we were fearful of the effect of greater power. We were told by some that the use of anything more than 1,000 watts would mean excessive blanketing, the blotting out of smaller competitors, the creation of large areas into which no other signals could enter. Some of the most pessimistic even warned us that our tubes would explode under the impact of signals of such great strength.

But our experience so far leads to the opinion that high power is not only harmless in these respects, but advantageous. Power increase has meant a general rise in broadcasting efficiency; it has meant clearer reception; it has helped greatly to overcome static and other difficulties inherent in summer broadcasting, so as to give us improved all-year service. Whatever the limit may be, I believe that substantial power increase has come to stay, and the public is the gainer from it.

SERVICE AREA

Our experience during the year has somewhat more clearly defined the geographical area within which a single broadcast sta-

Straight Frequency Line Tuning

Marks a new era in Radio progress—
Sweeping country like a tornado—
Fans welcome it with open arms—
Irresistable demand growing by leaps and bounds—

KARAS Started It

—and KARAS Is Carrying On!!

When we sprung the Karas Orthometric Condenser on a restless, hungry radio public—we knew we had started something. But we scarcely expected to be snowed under with such a literal avalanche of orders.

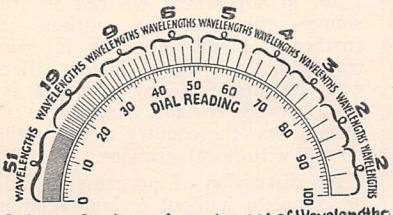
We inaugurated Straight Frequency Line Tuning at the psychological moment. Radio Fandom was waiting hungrily for something new. And here was something—not only new—but so perfectly simple—so thoroughly scientific—so downright sensible, that everyone wanted KARAS Orthometric Condensers at once.

Our scheduled production was like a drop in the bucket. Buyers pleaded—cajoled—even threatened. Our plans were doubled, trebled, quadrupled. But it all took time.

KARAS Orthometric Condensers could not be thrown together. It took months to train gangs to build them with the absolute *precision* KARAS demands. So tens of thousands had to wait or buy other makes, hurriedly assembled to supply the demand we had created.

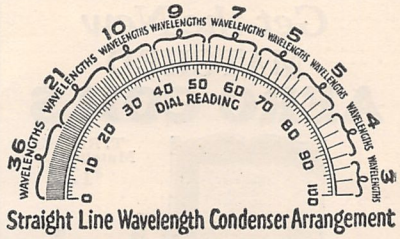
NOW—after months of preparation we are able to produce enough KARAS Orthometric Condensers to take care of at least a fair share of the demand. This announcement is an apology to those who were disappointed. A note of thanks to those who have waited. And a promise of revelation to those who have not yet discovered the marvelous advantages of Straight Frequency-Line Radio Tuning.

How KARAS Orthometric Condensers *Simplify the Tuning of any Radio Set*



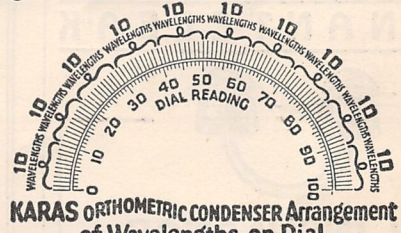
Ordinary Condenser Arrangement of Wavelengths

Ordinary straight capacity condensers crowd 70 of the 100 wave lengths into the first 30 points of the dial.



Straight Line Wavelength Condenser Arrangement

With straight-line-wavelength condensers 57 of the 100 wavelengths are crowded into the first 30 points on the dial.



KARAS ORTHOMETRIC CONDENSER Arrangement of Wavelengths on Dial

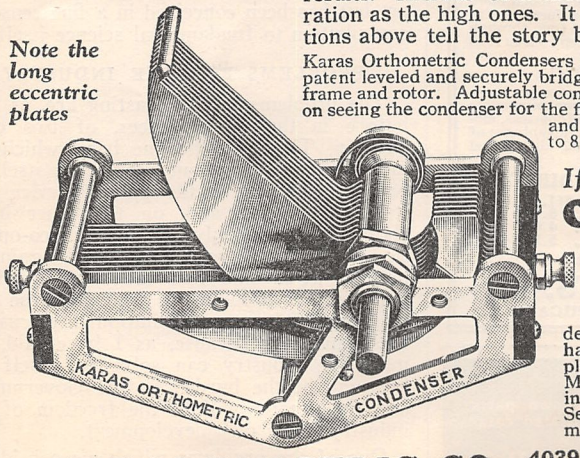
The New Scientific Karas Orthometric Condensers insure absolutely equal separation on the dial of all wavelengths throughout the entire broadcasting range.

Sizes and Prices—
23 plate, .0005 Mfd., $7.00
17 plate, .00037 Mfd., 6.75
11 plate, .00025 Mfd., 6.50
5 plate, .0000972 Mfd., 6.50

Government regulations separate all stations by an equal interval of 10 kilocycles. Old type condensers—straight line capacity and straightline wavelength—warped this uniform arrangement—crowding a lot of low wavelength stations into the first few degrees on the dial. Difficulty in tuning—confused heterodyning interference—garbling of programs—these were the results. KARAS Orthometric Condensers give low wavelength stations the same equal separation as the high ones. It is the last word in making ***real*** selectivity possible. The illustrations above tell the story better than words.

Karas Orthometric Condensers are both theoretically, and mechanically perfect. Made entirely of brass—plates patent leveled and securely bridged to insure permanent rigidity and alignment. Every joint soldered. Grounded frame and rotor. Adjustable cone bearings. Spring copper pigtail. In short, so beautiful a job that one engineer, on seeing the condenser for the first time, smilingly inquired, "How many jewels?" As proof of their mechanical and electrical efficiency, Karas Orthometric Condensers will hold a charge for from 6 to 8 hours, as against one hour to an hour and fifteen minutes for ordinary condensers.

Note the long eccentric plates



If your dealer hasn't secured a stock of Karas Condensers

Order on this Coupon!

Most good dealers everywhere, sell Karas Orthometric Condensers. If your dealer happens to be one who hasn't secured them, we will supply you direct on our 30-day Money-Back Guarantee. Just fill in and mail this coupon at once. Send no money. Pay your postman on delivery.

KARAS ELECTRIC CO., 4039 North Rockwell Street CHICAGO, ILLINOIS

For more than 30 years makers of PRECISION Electrical Apparatus

Karas Electric Co.,
4039 N. Rockwell St., Chicago

Please send me.....Karas Orthometric Condensers, size.....at $.....each. I will pay the postman the list price, plus postage, on delivery. It is understood that I have the privilege of returning these condensers any time within 30 days if they do not prove entirely satisfactory, and you will refund my money at once.

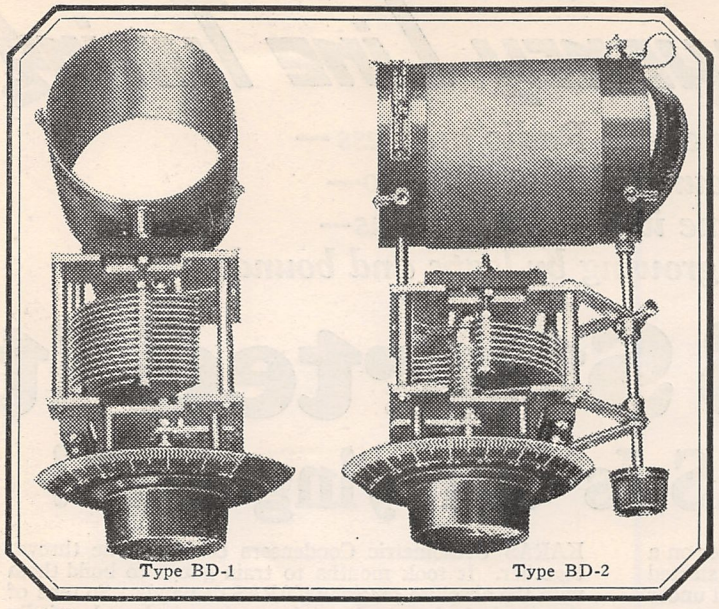
Name .....

Address .....

Dealer's Name .....

If you send cash with order, we'll send package postpaid

—RESULTS ARE TRULY AMAZING!



Type BD-1 Type BD-2

NATIONAL TUNING UNITS

(Patents pending.)

COMBINING THE

NATIONAL BROWNING-DRAKE Transformer

NATIONAL Condenser and the NATIONAL Velvet Vernier Dial

Set-builders all over the country, who have used these parts, report the same astonishing results. Use them for the popular circuits or hook-ups. They'll give supreme satisfaction.

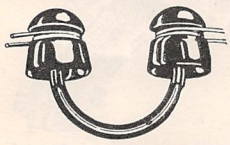
Get the Genuine. Insist Upon NATIONALS

NATIONAL COMPANY, Inc.

W. A. READY, President

Engineers and Manufacturers, Cambridge, Mass.

TWINANTELEAK



DX INSULATOR

The Twinanteleak Insulator is scientifically constructed. It will positively prevent leakage from your aerial wire. It is unquestionably the best insulator on the market under any and all weather conditions. The Twinanteleak cannot be affected by rain, snow, ice or dust.

All porcelain insulators absorb moisture and both porcelain and glass insulators leak when moist or wet. This leakage decreases the efficiency of reception. The Twinanteleak, as proven by tests, cannot leak. It is made of the best porcelain with a brown glaze, and has a 50 pound pull strength in its metal yoke.

Don't be misled: an outside aerial is essential for the best receptions. The best aerials are equipped with Twinanteleaks.

Use Twinanteleaks and get results.

Two Insulators for One Wire

$1.00

DISTRIBUTORS WANTED

TWINANTELEAK INSULATOR CO.

New Britain, Conn.

Get the New

MATCHED

AERO COILS

T. R. F. Kit Matched Coils $12.00

For SELECTIVITY and DISTANCE

Regardless of how good your set seems to be, you can make it many times more *selective* and much more *powerful* by replacing your T. R. F. transformers with Aero Coils. Get Aero Coils now — and tune through strong locals and bring in DX with tremendous loud speaker volume!

95% AIR DIELECTRIC

The secret of Aero Coils' markedly superior performance is its patented construction which makes possible the correct use of 95% air dielectric and dopeless, air-spaced windings with the consequent advantages of lower high frequency resistance and distributed capacity.

AT YOUR DEALERS OR DIRECT

T. R. F. Regenerative Kit	$11.00
3 Circuit Tuner	8.00
Wave Trap Coil	4.00
Oscillator	5.50

Write for the Aero Booklet

AERO PRODUCTS, Inc.

217 N. Desplaines Street, CHICAGO

A Laboratory Product

CRESCENT LAVITE RESISTANCES

for Distortionless Amplification

Insure distortionless amplifications and a clarity of tone not obtained through any other resistances. All capacities 12,000 ohms and up. List price $1.50. Special sizes to order. Write for full information.

Crescent Radio Supply Company, Liberty St., Jamaica, N. Y.

DEALERS!

Complete stock of nationally known parts and accessories. Send for illustrated catalog and discount sheet.

Radio Exclusively Since 1921

CLARK & TILSON, Inc.

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tion can give complete service. And by "complete service area" I mean the territory within which the average set can depend upon getting clear, understandable and enjoyable service from the station day or night, summer or winter. I do not include radio golf around the edge of these areas in our conception of public service—that game is an exercise of skill and efficiency of your set plus a gamble on the radio weather. But we are not here concerned with it. Actual operation of high-powered stations has proven advantageous in broadening the "complete service area," but this area is much more limited than many expected. Subjected to the test of positive and reliable service at all times and all weathers it will be found that the real effectiveness of a station falls within a comparatively small zone.

What these maximum areas of positive service are we do not yet know with any precision. The Bureau of Standards has recently carried on some rather extensive tests, and has accumulated some interesting information, though it is not yet ready to give us any definite figures.

If, however, we set up the most rigid standard of, say complete service in adverse atmospheric conditions, and all times of day and year for the average crystal set, then the Bureau's actual intensity measurements would seem to indicate that this radius of the circle served by a 500-watt station will not exceed ten miles, and that a 5,000-watt station will cover about 30 miles and 50,000-watt stations will not cover much over 100 miles. Obviously, more sensitive receiving sets, or better atmospheric conditions, at once greatly extend these distances.

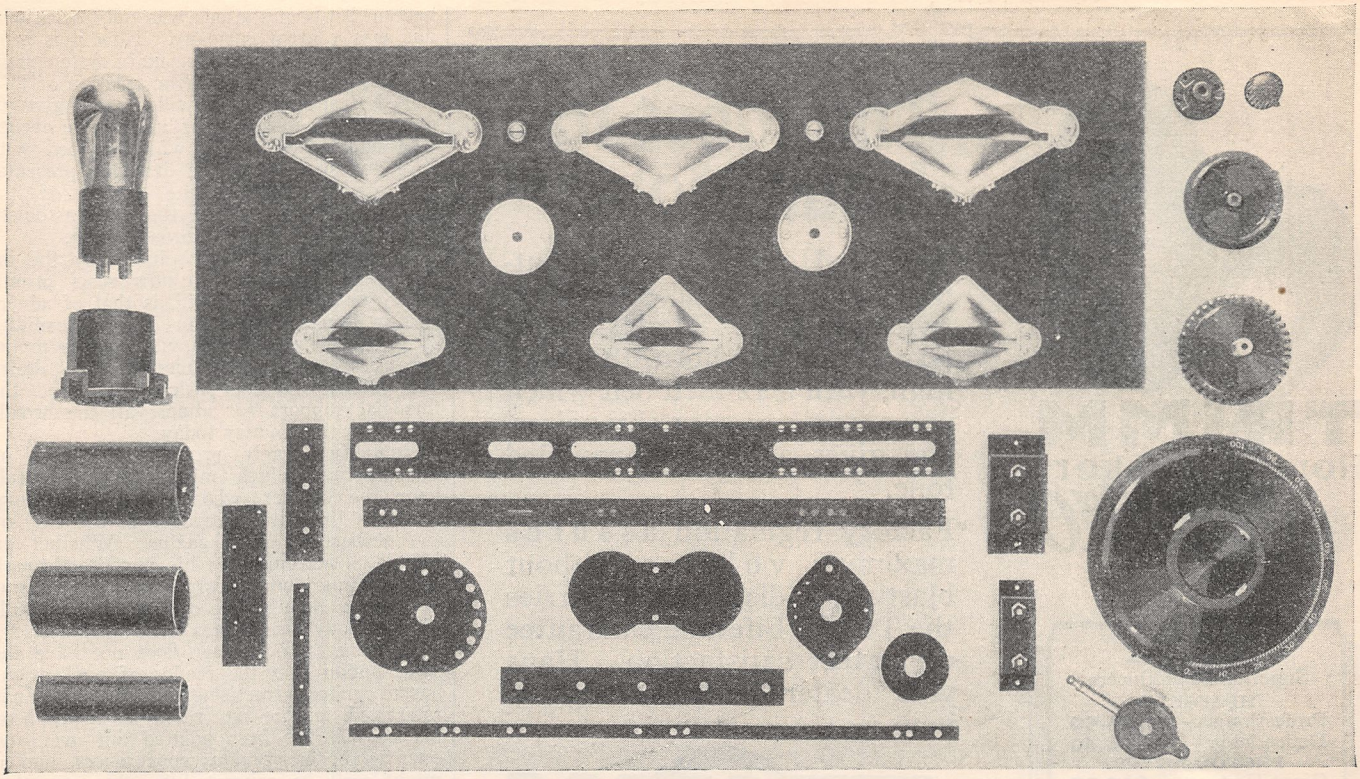
For some reason or other, the area is not always a circle, as you know, and it varies in different parts of the country for the same power. The department is undertaking the important task of determining these service areas, and you will have an opportunity while here of inspecting some of the equipment we are using for this purpose. I am in hopes that we can secure the resources this year to continue the study further. It will give us information on which to base more efficient allocation of wave-lengths. In any event, it is obvious that, barring revolutionary discoveries, it is certain that the country must continue to be served with local stations.

No discussion of progress in radio would be complete without an appreciation of the intensive scientific and industrial research now in progress in our universities and in the great laboratories of our commercial concerns, notably the General Electric, Western Electric, Westinghouse, and others, and, I might add, in our own Bureau of Standards. The vast expenditure of money and skill in our great industrial laboratories is not only advancing the application of the art but has been conceived in a fine sense of contribution to fundamental science itself.

PROBLEMS FOR THE INDUSTRY

The problems in broadcasting are, as ever before in these conferences, of two categories: Those on the one hand which the industry can and should solve for itself in order to safeguard the public service and its own interest, and, on the other hand, those which can only be solved in co-operation with the Government. And again, as before, we should find the solution of as many of our problems as we can in the first category. I have no hesitation in discussing these questions because, as I have said, the more the industry can solve for itself the less will be the burden on the Government, and the greater will be the freedom of the industry in its own development.

One of the problems which we considered at the last conference was that of interconnection. This has proceeded during the year in splendid fashion without any necessity of artificial stimulation. A year ago intercon-



Imagine a Radio Set stripped of these parts

What a useless collection of wood, wire and metal it would be. Realizing that the parts and accessories shown here are wholly or partly of Bakelite, gives you a vivid picture of its importance to Radio.

Today Bakelite is used in a greater variety of radio parts than ever before—and the number grows constantly. This dominance of Bakelite in radio reflects the experience and the opinions of radio manufacturers, great and small.

Radio set and parts manufacturers have every facility for testing all insulation materials and over 95% have standardized on Bakelite. This indicates how really important it is for you to make sure that the set or parts that you buy are Bakelite insulated.

Write for Booklet 24

BAKELITE CORPORATION

247 Park Avenue, New York, N. Y.
Chicago Office: 636 West 22nd Street

Bakelite is an exclusive trade mark and can be used only on products made from materials manufactured by the Bakelite Corporation. It is the only material which may bear this famous mark of excellence.

BAKELITE

REG. U.S. PAT. OFF.

BAKELITE is the registered trade mark for the phenol resin products manufactured under patents owned by Bakelite Corporation

THE MATERIAL OF A THOUSAND USES

The Most for Your Money

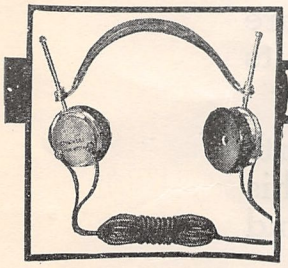
Trimm Home Speakers outperform other speakers costing twice as much. Model 25 has large Volconite horn, 18 inches high, with a 12 inch bell which prevents tinny, scratchy noises, and gives a full well-rounded tone.

Factory regulation assures maximum volume without blasting or distortion. Carries the Trimm Lifetime Guarantee of perfect satisfaction. Have your dealer demonstrate it to you.

TRIMM
Superior Reproducers

HEADSETS	
Professional - -	$5.50
Dependable - - -	4.40
PHONODAPTERS	
Giant Unit - -	$10.00
Little Wonder -	4.50
SPEAKERS	
Home Speaker -	$10.00
Entertainer - -	17.50
Cabinette - - -	17.50
Concert - - -	25.00
Chello - - -	30.00

TRIMM
RADIO MANUFACTURING COMPANY
24 So. Clinton St.
CHICAGO
U.S.A.



RADIO as you like it

CAMCO would make the Sphinx hear!

Cannon-Ball Headsets

THE world's greatest artists will be on the air during the next three months. You'll want to listen to them with the minutest attention so that you may grasp the technique and quality of these glorious voices. USE A HEADSET. It reproduces with exactness and shuts out all disturbing noises. The music comes to you clear and natural, pure in tone and quality.

Tune down your radio receiver to eliminate noises and know the fidelity and naturalness with which music and speech is reproduced thru a good headset.

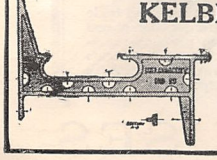
With a Headset such as the light weight, comfortable Cannon-Ball or Cannon-Ball Junior, you'll get more out of one high-grade concert than you pay for the Phones. Think of the hours of dependable enjoyment thereafter.

For long distance reception, you naturally choose a headset. If you have enough headsets, every member of your family will enjoy Radio as you like it. Examine the following Headsets, GUARANTEED by a well established, reliable manufacturer.

Cannon-Ball $3.50; Cannon-Ball Junior $2.75; Grand $4.75; Cannon-Ball Loud Speaker $12.50. At your dealer's.

CANNON & MILLER COMPANY, Inc. **SPRINGWATER, N. Y.**

Build your set with KELBRAKETS



Beauty, strength and accessibility for home-built sets. Write for booklet with full size illustration.
KELLERADIO, INC.
821 Market St., San Francisco, Calif.

BUILDING A SET?

You must have rheostats of correct ohmage. Insist on the genuine
KLOSNER RHEOSTATS
Made by pioneer makers of the vernier. FREE.—Send for valuable Rheostat Chart and information on the care and operation of vacuum tubes. Mention dealer's name.
KLOSNER RADIO CORPORATION
1024 East 178th St. *Rheostat Specialists*, N. Y. C.

nection between stations was only occasional and was a great curiosity. Now it is commonplace. It is becoming more systematized and has gone far toward the creation of long linked systems which will finally give us universal broadcasting of nationwide events. The number of people who throbbed with joys and sorrows at the dramatic presentation of minute-to-minute events of the world's series is one of the most astonishing landmarks in radio broadcasting.

Another problem for solution by the industry itself and which now rests prominently on the public mind, is that of advertising. There lies within it the possibility of grave harm and even vital danger to the entire broadcasting structure. The desire for publicity is the basic motive and the financial support for almost all the broadcasting in the country today.

Publicity largely provides the cost of broadcasting which might otherwise fall upon the listener, who now pays nothing, much as the advertiser does in the case of the newspaper or magazine. Whether an individual accomplishes his purpose through the building and operating of his own station or by hiring time on one already built by somebody else makes little difference.

But the radio listener does not have the same option that the reader of publications has to ignore advertising in which he is not interested, and he may resent its invasion of his set. It has been pointed out over and over again in previous conferences, and it might well be reiterated by this one, that advertising in the intrusive sense will dull the interest of the listener and will thus defeat the industry. Furthermore, it can bring disaster to the very purpose of advertising if it creates resentment to the advertiser. If we can distinguish, on one hand, between unobtrusive publicity that is accompanied by a direct service and engaging entertainment to the listener and unobtrusive advertising on the other, we may find solution. I believe the conference could well consider a definition of this distinction all along the line.

Another problem that the industry could quite well stimulate is the removal of stations from congested centers. Blanketing of reception is inevitable within some short range of every station, and when it is in town it affects thousands of people. Remote control has developed to the point where city studios operate perfectly with the transmitters far outside the city limits. I look forward to the not distant time when all stations of sufficient size to cause disturbance will be banished from the cities and when their blanketing annoyances will cease. The conference could render a definite service by formulating proposals to that end.

PROBLEMS FOR SOLUTION BY CO-OPERATION WITH THE GOVERNMENT

My major purpose today is to discuss those problems which must be solved in cooperation with the Government.

Up to the present time, we have had a policy of absolute freedom and untrammelled operation, a field open to all who wished to broadcast for whatever purpose desired. I am convinced that policy was sound. It resulted in a wonderfully extensive development which could have been obtained in no other way. We have today 578 stations, and as no more than four of them are under the same management, no one can say there is not plenty of competition. Today every solitary channel in the ether is occupied by at least one broadcast station and many of them by several. Of the 578 stations, 197 are using at least 500 watts of power, and there are now pending before the Department of Commerce over 175 applications for new licenses.

Higher power has greatly strengthened the service to listeners, but it has aggravated the problem of providing lanes through the traffic, for geographical separation must be greater. Heretofore, it has been possible

Helpful Information

of Utmost Importance to Owners of Models L-1 and L-2

ULTRADYNE

Receivers

NOW, after two years, I have found a new development that is of vital interest to all owners of both Models L-1 and L-2 Ultradyne Receivers.

Thousands of Ultradyne owners have asked us to solve this very problem. It deals with an easier, more economical method of operation and maintenance of your present Ultradyne Receiver.

If you have ever written us about any phase of your Ultradyne, write us again. We are now able to give everyone helpful information that has never been available before.

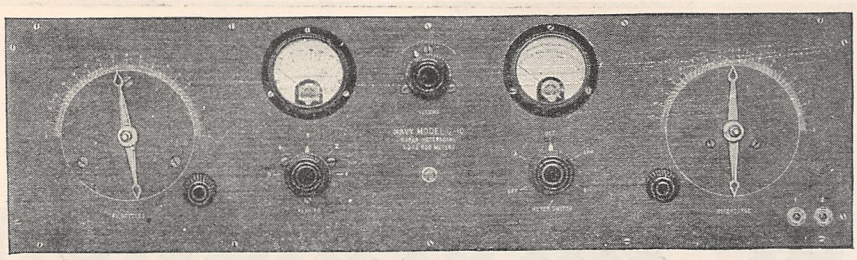
While this information applies directly to the Ultradyne (Models L-1 and L-2), it will prove of equal value to owners of all types of Super-Heterodyne receivers.

Complete details, as a part of our service, will be given, without cost, if you write at once.

Address all correspondence to Mr. R. E. Lacault, Phenix Radio Corporation, 114 East 25th Street, New York City.

R. E. Lacault

Chief Engineer,
PHENIX RADIO CORPORATION.



NAVY MODEL C-10 Super-Heterodyne

The Highest Class Receiver in the World

Wave length range 50-600 meters with removable Coils.
Panel Dimensions 28 3/16 in. x 8 in. x 1/4 in.
Only two major tuning adjustments.
Total amplification almost 2,000,000 times.

No Batteries

are required even to operate the most powerful 10-tube receiver pictured above, if you use the new laboratory type

Model A Power Unit

A high powered 10-tube Broadcast Receiver capable of receiving over 3,000 miles under favorable conditions, and having a degree of selectivity far in advance of others.

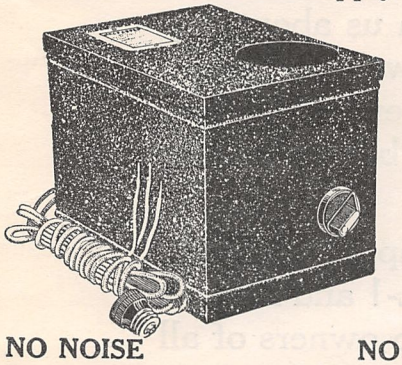
We believe the Navy Model C-10 represents final superiority over any receiver now being manufactured or even contemplated for broadcast reception.

Attractive illustrated literature gladly mailed upon request. Write direct to

NORDEN-HAUCK, INC.
Engineers
1617 Chestnut Street, Philadelphia, Penna.

MacFADDEN B-POWER GENERATORS

Supply your set with an unfailing, uniform supply of B-battery current



These unfailing instruments have given utmost satisfaction since their inception. Protect your investment when purchasing, by buying a MacFadden B-power Generator and eliminate B-battery annoyances for all time. MacFadden B-power Generators have a wide range of usefulness—for sets of five tubes or more use U.X. 213—smaller sets, U.V. 210A. Hook into your light line 110 V. 60 Cycle A. C. house current—no further attention required—just switch on or off.

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to duplicate channels geographically to a large extent among those using 500 watts, but with the increase of power, this system becomes more and more difficult, for the borderland of interference is wider spread. We must face the actualities frankly. We can no longer deal on the basis that there is room for everybody on the radio highways. There are more vehicles on the roads than can get by, and if they continue to jam in, all will be stopped.

It is a simple physical fact that we have no more channels. It is not possible to furnish them under the present state of technical development. It takes no argument to demonstrate that 89 wave-lenghs (and no more are available) cannot be made to serve innumerable stations, no matter how ingenious we may be in arranging time divisions and geographical separations. It is not a question of what we would like to do, but what we must do.

One alternative, which would only partly solve the problem, would be to increase the number of stations by further dividing the time of the present stations down to one or two days a week, or one or two hours a day. From the listener's viewpoint, and that is the only one to be considered, he would get a much degenerated service if we were to do that. It is quality of program, location and efficiency of transmission that count. None of these will be improved, and in most cases they will be ruined by introducing more stations to traverse the same channels. A half dozen good stations in any community, operating full time, will give as much service in quantity and a far better service in quality than 18, each one-third time.

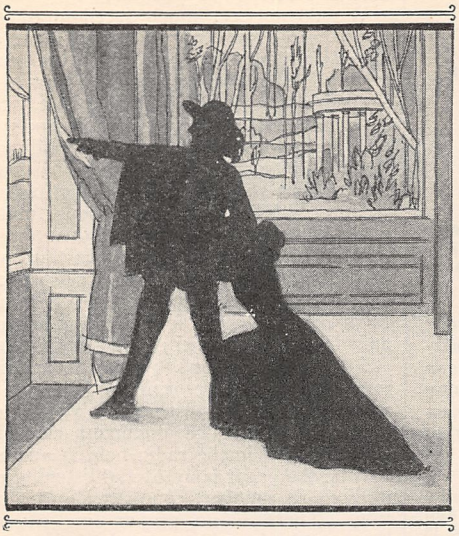
As the art progresses the capital investment in a good station has risen to upward of $150,000, and to provide technical staff, good talent and interconnection the cost of operation has risen to as much as $100,000 per annum, and frequently even more. The costs are in large part the same whether the station works one day in a week or seven. If we impose more division of time than at present we shall drive the best station out of action and the public will be more poorly served. The choice is between public interest and private desire, and we need not hesitate in making a decision. There are, of course, some stations of special character which can divide time, but they do not often lie in congested territory.

It has been suggested that the remedy lies in widening the broadcasting band, thus permitting more channels and making it possible to provide for more stations. The vast majority of receiving sets in the country will not cover a wider band. Nor could we extend it without invading the field assigned to the amateurs, of whom there are thousands, and to whose constant experimentation radio development is so greatly indebted. Radio in this branch has found a part in the fine development of the American boy, and I do not believe anyone will wish to minimize his part in American life.

If we did absorb the upper amateur band from 150 to 200 meters, it would not even solve the immediate difficulties. All these things bring us face to face with the problem which we have all along dreaded and for which we have hoped the development of the art might give us a solution. But that appears to be far off, and me must now decide the issue of whether we shall have more stations in conflicting localities until new discoveries in the art solve the problem.

We hear a great deal about the freedom of the air. But there are two parties to freedom of the air, and to freedom of speech, for that matter. There is the speech-maker and the listener. Certainly, in radio I believe in freedom for the listener. He has much less option upon what he can reject, for the other fellow is occupying his receiving set. The listener's only option is to abandon his right to use his receiver. Free-

"HOW WELL YOU CAN HEAR" IS THE THING THAT COUNTS



"Shadow Voices" GONE FOREVER

A New Loud Speaker Principle Ends this Common Speaker Fault

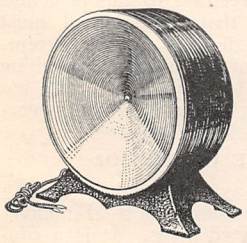
—gives you all the thrill of the first row orchestra

NOW you can get the full joy of radio. Those thin, tinny piano notes, those muffled, nose-holding singers' voices—mere shadows of the living, thrilling originals—are gone forever.

Now by a new principle, that of the "double free-edge cone," the new Acme loud speaker gives you volume reproduction of the human voice and all musical instruments with faithful exactness. It fills and rounds out, puts life, fire, reality, into the shadowy phantom voices you have been so accustomed to hearing.

Clear as if you sat in the "bald headed" row

At home in an arm chair, you can now sit back and enjoy broadcasting as fully as if you were in the famous "bald headed" row. Whether you listen to an operatic selection, or a roaring, howling prize fight, you get every sound, every slightest variation of expression that is picked up and broadcast by the microphone. No tense straining to make out muffled voices—no disappointment. You hear the natural voice speaking—not a megaphone.



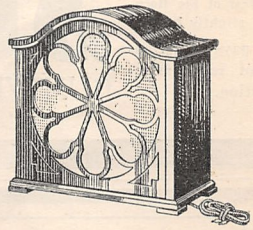
The Acme "double free-edge cone" loud speaker. Puts back into the so-called "shadow voice" the living, recognizable, individualistic tones of each speaker. Round model (shown) $25.

The cause of "shadows"

The cause of "shadow voices" is distortion; the inability of the loud speaker to clearly reproduce the delicate over and under-tones which make one man's voice different from another's. This distortion produces a continual blurring, sing-song monotone, not only sleep-producing, but actually impossible to understand without close concentration.

Musical instruments such as the piano are particularly affected. A marvelous toned, two thousand dollar concert grand piano sounded like the tinny tinkling of a 20 year old untuned upright.

But, now, after 5 years' effort and the testing of 256 different experimental models, the new Acme "double free-edge cone" loud speaker gives you front row seats at any broadcast entertainment.



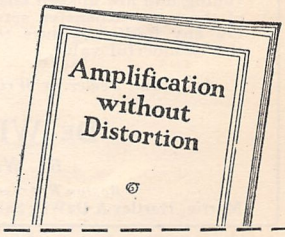
The Acme "double free-edge cone" loud speaker. Puts back into the so-called "shadow voice" the living, recognizable, individualistic tones of each speaker. Cabinet model (shown) $35.

Send for this book

The new Acme "double free-edge cone" loud speaker is now on exhibition at all Authorized Acme Dealers and Service Stations. A thrill of sheer delight is in store for you—be sure to hear it. In the meantime, send for the complete story of distortion and how you can overcome it in the set you build or buy. The book, "Amplification without Distortion," tells you how. The 10th edition is now ready. Over 220,000 Acme friends have found it helpful. Perhaps you will find it useful, too. At any rate send for it and see.

Claude Hairns

President, Acme Apparatus Co.



ACME

~for amplification

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Enclosed find 10c stamps or coin for my copy of "Amplification without Distortion."

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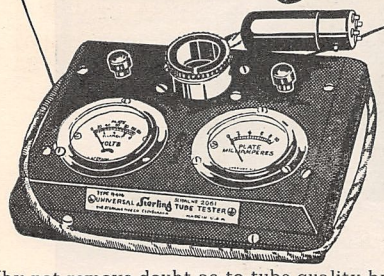
Street .....

City ..... *State* .....

The Radio "Gift of Service"



Thinking of Radio for Christmas?

—then make sure of prolonging the joy of your radio gift throughout the year. No radio receiving set regardless of price, will give continuous satisfaction unless the tubes are right. A single bad tube in a set may mean poor reception from local stations and utter failure to get distant points.

Why not remove doubt as to tube quality by giving a Sterling Universal Tube Tester built especially for set owners to check up the ever-changing values of tubes while they are in use—to test "A" and "B" batteries—to find weak sockets—open circuits—troublesome transformers. The Sterling is truly a universal home set-server and anyone can operate it.

For the friend who owns a set no gift could be more appreciated than the Sterling Universal Tester. Nothing in radio will so much insure permanent satisfaction. And if you are going to be Santa Claus to yourself, you could not spend your radio Christmas money to better advantage.

See a Sterling dealer now and scratch another gift problem off your list.

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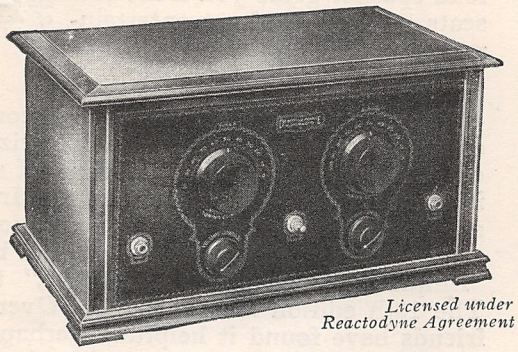
5 Tubes
2 Dials
S. L. F. Condensers



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Price $56

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Insist on having your tubes tested on the wonderful SUPERADIO DYNOMETER. Measures Amplification Factor, Plate Impedance and Mutual Conductance of any tube.

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MUTER
Dependable Resistance Amplifiers completely assembled $8.00

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dom cannot mean a license to every person or corporation who wishes to broadcast his name or his wares and thus monopolize the listener's set.

We do not get much freedom of speech if 50 people speak at the same place at the same time, nor is there any freedom in a right to come into my sitting room to make a speech whether I like it or not. So far as opportunity goes to explain one's views upon questions of controversy, political, religious or social, it would seem that 578 independent stations, many competing in each locality, might give ample opportunity for great latitude in remarks. And in any event, without trying out all this question, we can surely agree that no one can raise a cry of deprivation of free speech if he is compelled to prove that there is something more than naked commercial selfishness in his purpose.

The ether is a public medium, and its use must be for public benefit. The use of a radio channel is justified only if there is public benefit. The dominant element for consideration in the radio field is and always will be the great body of the listening public, millions in number, countrywide in distribution. There is no proper line of conflict between the broadcaster and the listener, nor would I attempt to array one against the other. Their interests are mutual, for without the one the other could not exist.

There have been few developments in industrial history to equal the speed and efficiency with which genius and capital have joined to meet radio needs. The great majority of station owners today recognize the burden of service and gladly assume it. Whatever other motive may exist for broadcasting, the pleasing of the listeners is always the primary purpose. There is a certain analogy to our newspapers and periodicals, but the analogy is not complete. A newspaper survives upon the good-will of its subscribers. It has intimate knowledge of their number and there is a delicate and positive sensitiveness in the reflex of their good will or ill will. But the broadcast stations has little knowledge of the number of its listeners and much less ability to judge their ill will or good will. There is no daily return of rise and fall in circulation. If someone could invent a method of accurate touch it might solve our problems, for I am convinced that some stations are broadcasting, not to receiving sets, but only to the ether.

The greatest public interest must be the deciding factor. I presume that few will dissent as to the correctness of this principle, for all will agree that public good must overbalance private desire. But its acceptance leads to important and far-reaching practical effects, as to which there may not be the same unamity, but from which, nevertheless, there is no logical escape.

WHAT ARE WE TO DO?

We simply must say that conditions absolutely preclude increasing the total number of stations in congested areas. It is a condition—not an emotion. But this implies a determination of who shall occupy these channels, in what manner, and under what test.

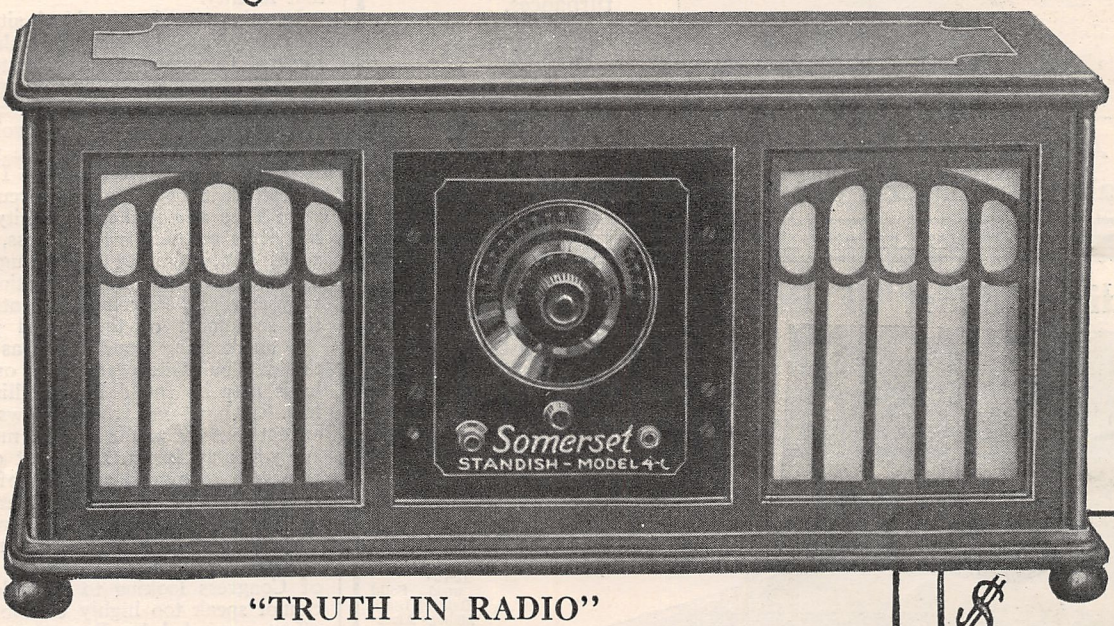
I can see no alternative to abandonment of the present system, which gives the broadcasting privilege to everyone who can raise the funds necessary to erect a station, irrespective of his motive, the service he proposes to render, or the number of others already serving his community. Moreover, we should not freeze the present users of wave-lengths permanently in their favored positions irrespective of their service. That would confer a monopoly of a channel in the air, and deprive us of public control over it. It would destroy the public assurance that it will be used for public benefit. There are, indeed, many difficult issues to be solved, but we have to face them just the same.

It seems to me we have in this development of governmental relations, two distinct

Somerset

Truth in Radio

STANDISH MODEL 4-C



"TRUTH IN RADIO"

$110

Synchronized, Single Master Control Gives Greatest Simplicity of Operation

Ever since SOMERSET Radio made its appearance two years ago, these beautiful sets have endeared themselves to the public on account of absence of extravagant claims.

SOMERSET Standish Model 4C achieves absolute simplicity in operation. *One synchronized control takes care of all major tuning for local stations.* A vernier control underneath the large dial is used only when listening to distant stations.

This is a 4-tube set entirely enclosed in an antique mahogany, two-tone, beautifully inlaid cabinet, with built-in Utah Loud Speaker, the best that money can buy. There is space for both "A" and "B" batteries in this large cabinet. Not just a cabinet, but a perfect piece of furniture. The total size of the cabinet is 28½"x 13"x13½".

Storage batteries or dry cells can be used. Standish Model 4C operates from 200 to 600 meters. There is an automatic filament control, eliminating chances of burning tubes too brightly and does away with extra controls.

Straightline Frequency condensers of the latest type do away with crowding of the short-wave stations.

This receiver is the best and most pleasing model of the SOMERSET line of modern radio receivers. It is handsome, powerful, and practical throughout—built by men who have been in the radio business since 1908.

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Extra valuable dealer franchises for the SOMERSET line are still open to some dealers who are interested in the better model receivers that are ready for quick installing, backed by a liberal advertising campaign in your own territory. Write for complete plan. *Wire for your territory or use this coupon, as we are closing all territory rapidly.*

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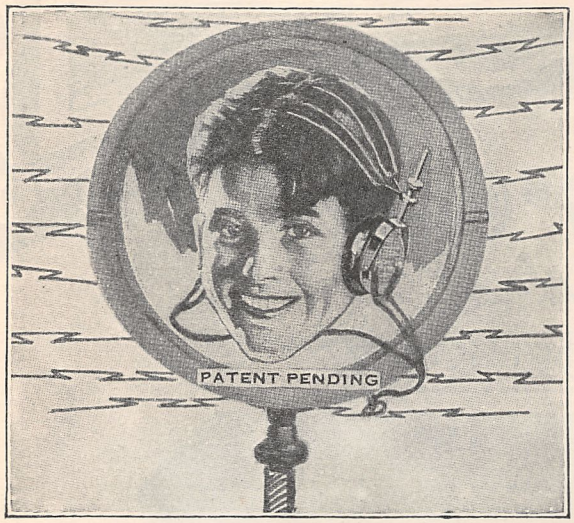

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1. Increases Selectivity.
2. Non-Directional.
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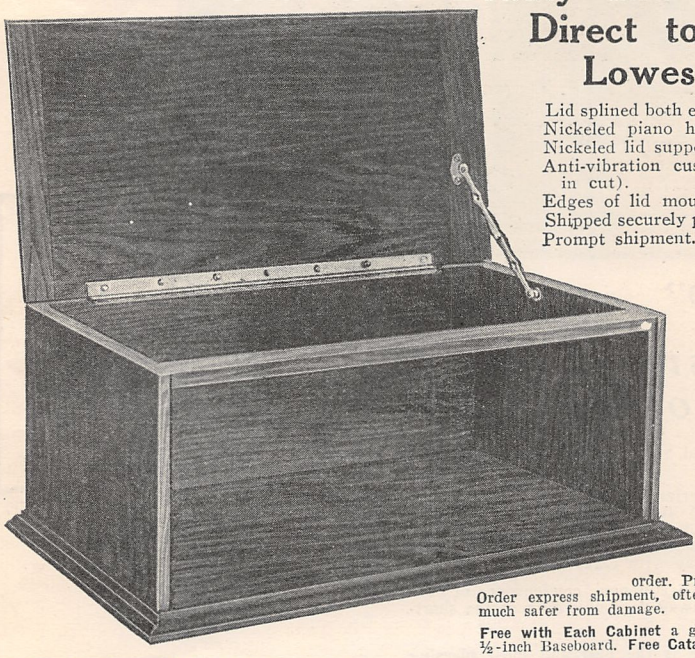

Lid splined both ends to prevent warping.
Nickeled piano hinge—Full length.
Nickeled lid support of artistic design.
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Shipped securely packed in strong carton.
Prompt shipment. Big stock for holidays.

	Hardwood Finish Mahogany	Solid Rubbed Black American Walnut
7x18x7½ or 10 in. deep	$3.50	$5.00
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Add 25c for "E-Z" Fone Plug.

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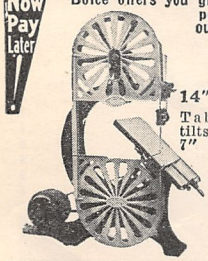

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Table 12"x14" tilts 45 deg. Saws 7" stock. Uses blades 3/16" to ½" wide. Bronze Bearings.

8" Bench Lathe
Does turning, drilling, sawing, sanding, grinding, and jig sawing in wood or soft metals. Supplied also with compound rest. Swings 8". Capacity 20" between centers.

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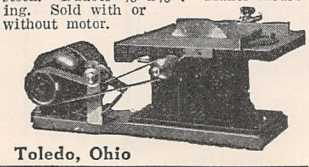

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problems. First is a question of traffic control. This must be a federal resposibility. From an interference point of view, every word broadcast is an interstate word. Therefore, radio is a 100 per cent. interstate question. And there is not an individual who has the most rudimentary knowledge of the art who does not realize that there must be a traffic policeman in the ether, or all service will be lost in complete chaos of interference. This is an administrative job, and for good administration must lie in a single responsibility.

The second question is the determination of who shall use the traffic channels, and under what conditions. This is a very large discretionary or a semi-judicial function which should not devolve entirely upon any single official, and is, I believe, a matter in which each local community should have a large voice—should in some fashion participate in a determination of who should use the channels available for broadcasting in that locality.

In other words, the ideal situation, as I view it, would be traffic regulation by the Federal Government to the extent of allotment of wave-lengths and control of power and the policing of interference, leaving to each community a large voice in determining who are to occupy the wave-lengths assigned to that community. It is true, of course, that radio is not circumscribed by state lines and still less by city boundaries. But it is possible, nevertheless, to establish zones which will at least roughly approximate the service areas of stations, and to a very considerable extent to entrust to them the settlement of their local problems.

I am seeking your views as to how far this can be made practicable, or what other basis may be found for handling the problem. I have no frozen views on radio—except that the public interest must dominate. As you may know, I am not one of those who seek to extend any sort of government regulation into any quarter that is not vital, and in this suggestion I am even endeavoring to create enlarged local responsibility.

Much work has been done in past sessions of Congress looking to radio legislation. I cannot speak too highly of the constructive effort expended by Representative Wallace White and his committee associates in the study of radio needs and the preparation of measures to meet them. But until the present time I think we have all had some feeling of doubt as to the precise course which legislation should take, for changes have been so rapid and conditions so shifting that no one was ready to try to chart an exact course. I am glad that Congressman White and other members of the House and Senate Committees are with us in this conference. I am certain that they have a hearty sympathy with, and understanding of, the actual needs of the radio public.

To sum up, the major problems for consideration are, to my mind: (a) Is public interest paramount? (b) Shall we limit the total number of stations in each zone pending further development of the art? (c) What basis shall be established for determining who shall use the radio channels? (d) What administrative machinery shall we create to make the determination?

(*Continued on page* 1089)

One-Tube Regenerator Brings in Coast

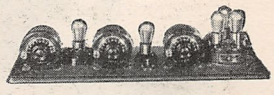
(*Continued from page* 962)

the advancement of radio broadcast in general, or to aid him in getting a proper technical check on our signal will be greatly appreciated.

Mr. Angel, Jr., is our Eastern outpost guide for the purpose of aiding us to broadcast to the best of interests.

Very truly yours, RADIO KNX,
By J. W. Van Why, Chief Radio Engineer.

ATWATER KENT RADIO



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RADIO SPEAKERS priced from $12 to $28

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This is a new influence in Radio

In many ways the Atwater Kent Model 20 Compact is a new influence in the progress of radio.

It is unobtrusive. It takes its place gracefully on a small table, a book rack or any other small piece of furniture, for it is a fine, simple electrical instrument only 6½ inches high and 19¾ inches long—no larger than a row of a dozen books.

So now Radio needn't disturb any room. You can fit it agreeably into your present arrangement of furniture and decorations, without buying anything new.

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WSAI	*Cincinnati*
WOC	*Davenport*
WCAP	*Washington*
WTAG	*Worcester*
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WFI, WOO	*Philadelphia alternating*

Never before used in DIALS!

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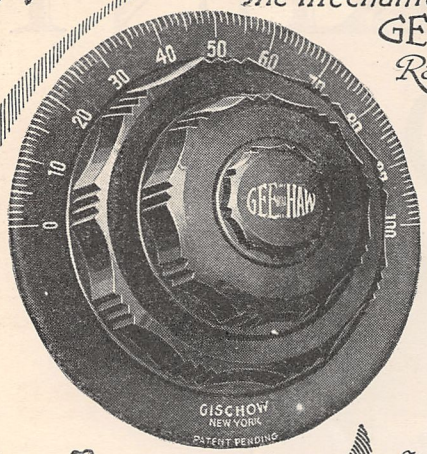
Ratio 100 to 1 --- No Backlash



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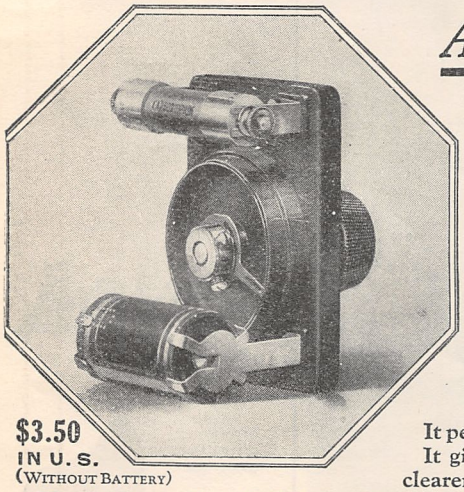

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It gives greater sensitivity—increased selectivity—clearer tones.

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The following letter is from another West Coast station which does not happen to be in the usual run of calls heard by the fan in the district of New York:

Long Beach, Calif.,
April 27, 1925.

Laurance Angel, Jr.,
Huntington, L. I., N. Y.

Dear Sir:

Just received your letter of the 23rd and note what you say.

I might say that we are hearing from New York State quite regularly, and our record for distance is Apia, Samoa. It is said we have the freak station in America.

Our wave-length is 232 meters, and our power is only 100 watts. Our station is located on the top of the Markwell Building, Long Beach, Calif., about sixty feet from the ocean front.

We thank you for your letter. If you pick up our station in the future we shall be pleased to hear from you.

Very truly yours,

HAL G. NICHOLS,
Announcer of KFON.

After looking over the imposing array of DX letters and cards, and noting the extreme simplicity of the set and the hook-up used in the circuit, we asked Mr. Angel to what he attributed his extreme record.

"It seems to be more a trick of location than anything else. The multiplicity of aerials helps, of course, as does the nearness of the ground to the Sound. Also there is the fact that I have been working with this set just as it stands for almost two years and so know pretty well all its ins and outs.

"When you call to mind that the ordinary aerial system is less than 100 feet in length and that is is none too well constructed, it is easy to see that the one here is bound to give much more power to the grid of the tube. You must have the original power before amplification will do any good."

A sketch of the complete antenna system is shown in one of the accompanying diagrams.

After we had looked over the station, Mr. Angel showed us his log. It contains more than 500 stations. This is almost the complete number of broadcasters in the United States. Further, it is complete and accurate in every detail. Not only does it give the call of the station, its wave-length and power, but it sets out the settings of the various dials which brings in the stations. And what is probably more noteworthy, a resetting of the dials to the point almost always brings in the station.

Mr. Angel, who is 17 years old and a student at the local high school, gives a description of the set which he built with the help of his father:

"Referring to the diagram, notice the inductance coil tuning the antenna and grid circuits. The rotor of the variocoupler has 48 turns. The primary has 64 turns. The primary inductance is tapped at the following turns: 1, 2, 3, 4, 5, 6, 7, 15, 24, 33, 41, 51, 60 and 64. These taps are brought to two sets of points and switches which are mounted on the panel in the customary tens and units combination. All taps from one to seven are incorporated in one switch, while the remaining taps are at the other.

"A .001 mf. variable condenser is connected in series with the ground lead. This condenser is shunted with a three-plate vernier variable.

"A fixed condenser is also employed in series with the aerial lead. This has a capacity of .0005 mf.

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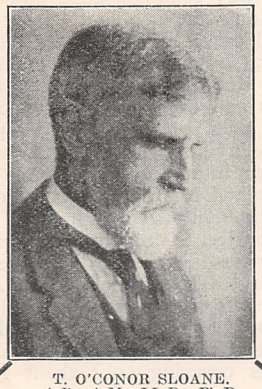

T. O'CONOR SLOANE, A.B., A.M., LL.D., Ph.D.
Noted Instructor, Lecturer and Author. Formerly Treasurer American Chemical Society and a practical chemist with many well known achievements to his credit. Not only has Dr. Sloane taught chemistry for years but he was for many years, engaged in commercial chemistry work.

Do you remember how the tales of pirate gold used to fire your imagination and make you want to sail the uncharted seas in search of treasure and adventure? And then you would regret that such things were no longer done. But that is a mistake. They *are* done—today and everyday—not on desert islands, but in the chemical laboratories throughout your own country. Quietly, systematically, the chemist works. His work is difficult, but more adventurous than the blood-curdling deeds of the Spanish Main. Instead of meeting an early and violent death on some forgotten shore, he gathers wealth and honor through his invaluable contributions to humanity. Alfred Nobel, the Swedish chemist who invented dynamite, made so many millions that the income alone from his bequests provides five $40,000 prizes every year for the advancement of science and peace. C. M. Hall, the chemist who discovered how to manufacture aluminum made millions through this discovery. F. G. Cottrell, who devised a valuable process for recovering the waste from flue gases, James Gayley, who showed how to save enormous losses in steel manufacture, L. H. Baekeland, who invented Bakelite—these are only a few of the men to whom fortunes have come through their chemical achievements.

What Some of Our Students Say of This Course:

I have not written since I received the big set. I can still say that it far exceeded my anticipations. Since I have been studying with your school I have been appointed chemist for the Scranton Coal Co. testing all the coal and ash by proximate analysis. The lessons are helping me wonderfully, and the interesting way in which they are written makes me wait patiently for each lesson.—MORLAIS COUZENS.

I wish to express my appreciation of your prompt reply to my letter and to the recommendation to the General Electric Co. I intend to start the student engineering course at the works. This is somewhat along electrical lines, but the fact that I had a recommendation from a reliable school no doubt had considerable influence in helping me to secure the job.—H. VAN BENTHUYSEN.

So far I've been more than pleased with your course and am still doing nicely. I hope to be your honor graduate this year.—J. M. NORKUS, JR.

I find your course excellent and your instruction, truthfully, the clearest and best assembled I have ever taken, and yours is the fifth one I've studied.—JAMES J. KELLY.

From the time I was having Chemistry it has never been thus explained to me as it is now. I am recommending you highly to my friends, and urging them to become members of such an organization.—CHARLES BENJAMIN.

I shall always recommend your school to my friends and let them know how simple your lessons are.—C. J. AMDAHL.

I am more than pleased. You dig right in from the start. I am going to get somewhere with this course. I am so glad that I found you.—A. A. CAMERON.

I use your lessons constantly as I find it more thorough than most text books I can secure.—WM. H. TIBBS.

Thanking you for your lessons, which I find not only clear and concise, but wonderfully interesting. I am—ROBT. H. TRAYLOR.

I received employment in the Consolidated Gas. Co. I appreciate very much the good service of the school when a recommendation was asked for.—JOS. DECKER.

Experimental Equipment Furnished to Every Student

We give to every student without additional charge this chemical equipment, including forty-nine pieces of laboratory apparatus and supplies, and forty different chemicals and reagents. These comprise the apparatus and chemicals used for the experimental work of the course. The fitted heavy wooden box serves not only as a case for the outfit but also as a useful laboratory accessory for performing countless experiments.

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Not only are there boundless opportunities for amassing wealth in Chemistry, but the profession affords congenial employment at good salaries to hundreds of thousands who merely follow out its present applications. These applications are innumerable, touching intimately every business and every product in the world. The work of the chemist can hardly be called work at all. It is the keenest and most enjoyable kind of pleasure. The days in a chemical laboratory are filled with thrilling and delightful experimentation, with the alluring prospect of a discovery that may spell Fortune always at hand to spur your enthusiasm.

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To qualify for this remarkable calling requires elaborate specialized training. Formerly it was necessary to attend a university for several years to acquire that training, but thanks to our highly perfected and thorough system of instruction, you can now stay at home, keep your position, and let us educate you in Chemistry during your spare time. Even with only common schooling you can take our course and equip yourself for immediate practical work in a chemical laboratory. Dr. Sloane gives every one of his students the same careful, personal supervision that made him celebrated throughout his long career as a college professor. Your instruction from the very beginning is made interesting and practical, and we supply you with apparatus and chemicals for performing the fascinating analyses and experimental work that plays such a large part in our method of teaching, and you are awarded the Institute's official diploma after you have satisfactorily completed the course.

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R.N.-Jan. '26

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HERE is a *real* straight line frequency condenser at last—a condenser that *really* eliminates crowding, that *really* spaces stations evenly over the dials. It is the creation of Rasla, a name made famous by fine parts.

The RASLA STRATE-LYNE is built to standards usually adhered to only for laboratory precision instruments. The plates are *heavier* than on any other condenser, the spacing and alignment is more accurate. Split bushings are provided at *both* ends. The plates are acid dipped, the endplates nickeled and highly polished. Transparent bakelite insures *true* low loss.

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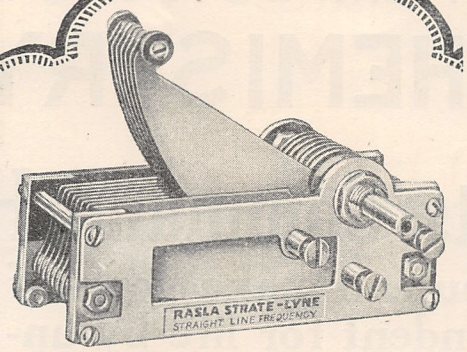

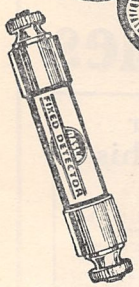

The Rasla Fixed Detector is sensitive—and remains so. Best for reflex or any circuit. At your dealer's $1.25

FREE—Write for the complete Rasla hook-ups.

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List Prices

.00025	$4.60
.0003	4.75
.00035	5.00
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At your dealer's or direct if he can't supply you.

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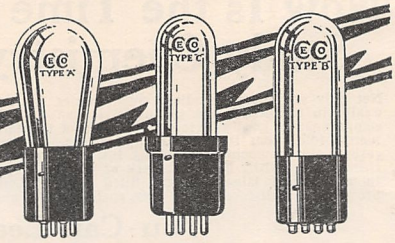
You can't judge tubes by appearance. They all look alike. But there's one easy way to be sure of PERFORMANCE. Buy CECO Tubes.

Then you'll get clearer, richer tone, greater volume, longer life. Our test charts, confirmed by recognized national authorities, PROVE this claim.

Ask about CECO Power Amplifiers.

CECO Radio Vacuum Tubes



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THESE are the *finest long distance* sets at the *lowest prices* in history. Wonderful new circuit that brings amazing results. SATISFACTION GUARANTEED. Everything furnished with complete sets. There's a set for *every pocket-book*.

5 TUBE SET—100 Amp. Storage "A" Battery, rubber covered "A" Battery Cable; "B" Battery, 90 V. 5 Tubes, Loud Speaker, Loud Speaker Plug, Antenna $95.95

3 TUBE SET—3 Dry Cells; "B" Battery, 90 V.; 3 Tubes, Loud Speaker, Head Phones, Antenna $49.95

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1 TUBE SET—1 Dry Cell; "B" Battery, 22½ V.; 1 Tube, Head Phones, Antenna.....$18.95

Sets also sold without accessories. Full line radio accessories and partly assembled kits.

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Play Jazz in a week

on your **Buescher Saxophone**

You can do it—easy. 3 lessons free with each new instrument give you a quick start. Practicing is fun because you learn so fast. And it will make you popular, in demand, the center of attraction everywhere you go. Always a hit. Even if you have failed with some other instrument, you can learn the simplified Buescher Saxophone. Don't delay. Get into the big fun. Any instrument sent for 6 days' free trial. Easy terms if you decide to buy. Write now for beautiful, free literature. Address:

Buescher Band Instrument Co.
1225 Buescher Block Elkhart, Indiana

"No grid condenser or grid leak is used.

"The tickler coil is shunted with a variable condenser of .0005 mf. capacity, and this, in turn, is shunted with another vernier variable condenser of .00004 mf.

"A UV-200 detector tube is used and is considered a valuable part of the set. A potentiometer of 200 ohms is shunted across the filament supply to this tube.

"A 1 mf. fixed condenser is shunted across the "B" battery. Another fixed condenser is placed across the leads to the telephones. This last condenser has a capacity of .001 mf.

"Outside of these few details, the receiver is of the conventional construction."

"Hello, Give Me S. S. Lucia"

(*Continued from page* 969)

means of radio telephony and was distinctly heard by all present. On this occasion it was only a one-way communication and the people in London were unable to reply by radio and could only send their congratulations of the feat by means of the existing cable systems. But this experiment showed the possibilities and experiments have been continued since then so that we may expect a service between New York and London in the fairly near future, and a station is being built in England for the purpose of carrying on the communications both ways. Of course, such a project is unfortunately somewhat limited by the fact that a difference of five hours separates New York from London, noon in the former city is five o'clock in the latter, so that the time available during the two cities business hours is restricted to conversations covering only about four useful hours.

From the foregoing it will be plainly seen that radio telephony has come to stay and it only remains for suitable legislation to be made to clear the way for this remarkable service to come well to the front along with the other public communication services.

The Radio Pup

(*Continued from page* 969)

All in all, it is at least the electrical equivalent of most of the one-tube sets that were selling a few years ago for several times its price. It gives excellent headphone volume on nearby stations, and when used with a good aerial is capable of bringing in night-time DX, under good conditions, from stations one thousand miles away, although this, of course, can only be accomplished by careful tuning and a little straining of the ears.

And if the maid mistakes it for a speck of dust, and sweeps it out of the back door, or under the rug as the case may be, what are the odds? You can get another for the price of a couple of theatre tickets.

SAVE THE FILAMENT

Filament control rheostats are keeping pace with other radio apparatus and constantly improving in design. Engineers are seeking to decrease the dimensions, improve the method of mounting and make a smoother current regulator of the old style rheostat.

Rheostats that are too large in size are difficult to use in many sets. It is difficult to reduce the size without sacrificing the current-carrying capacity of the larger rheostats, yet small rheostats are desirable.

Send for this Big Catalogue

CONTAINS THE NEW, EASY WAY TO BUILD YOUR RECEIVER

Book contains 36 pages 7x10 inches packed full of the most useful and interesting matter ever put into a radio catalog.

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"No-Sod-er" MAKES SET-BUILDING EASY

Revolutionary Method to "Build Your Own"

SHALL WE SEND YOU ALSO

New 1925 "Rasco" Parts Catalog No. 15

CONTAINS 75 VACUUM TUBE HOOK-UPS, 300 ILLUSTRATIONS 500 ARTICLES, 100 PAGES

All Armstrong Circuits: These important circuits are explained clearly, all values having been given, leaving out nothing that could puzzle you. Just to name a few of the Vacuum Tube circuits: The V.T. as a detector and one-step amplifier; all Armstrong circuits; one-step radio frequency amplifier and detector; three-stage audio frequency amplifier; short wave regenerative circuits; 4-stage radio frequency amplifier; radio and audio frequency amplifier; inductively coupled amplifier; all Reflex Circuits.

This Free Book Tells

About the Marvels of Radio—How it Helps All and Brightens Every Home—Gives List of Broadcast Stations—Specimen Programs—And How Programs are Made UP—Answers the Questions, "What Set Shall I Buy," and "How Much to Pay—Describes "No-Sod-er" Wiring System—Explains How to Get Your Own Radio Outfit Without Money—How to Save $65.00 in Five Hours—How to Make Money by Going Into Business for Yourself and Building Sets for Others—Tells Where Orders are Awaiting You—Where and How You Can Transact Your Business — CONTAINS DETAILED DESCRIPTIONS AND FINEST ILLUSTRATION OF LARGE NUMBER OF BEST KITS IN EXISTENCE AND QUOTES LOWEST PRICES—Lists Full Line of Radio Parts and Accessories—Explains Our Fair, Easy, Liberal, Golden-Rule Plan of Doing Business. You Need It. Send Coupon or letter NOW.

Book explains what you want to know

About new revolutionary way of assembling your radio set from our many kits—no solder, no bus bar, no poor connections, no waste of time, no skill required, no dissatisfaction, no tools needed except common screwdriver and pliers. Even a boy can quickly assemble a complicated kit.

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You may send me, without charge or obligation, your KIT CATALOG NO. 14 ( ) RASCO PARTS CATALOG NO. 15 ( ). I am interested chiefly in
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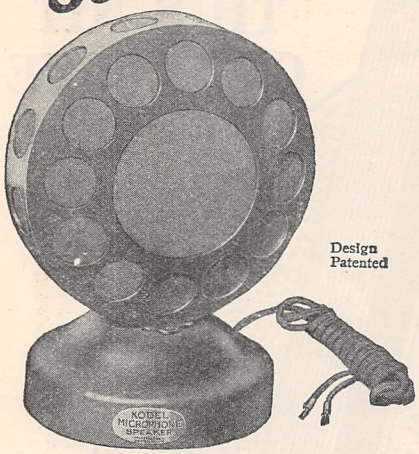

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The efficient KODEL SOUND UNIT, with an ingenious new snail-shell horn, mounted inside the microphone case, produces a remarkably clear, full-toned volume, with every note as rich and true as when it enters the transmitting microphone in the studio. Non-vibrating tone chamber absolutely eliminates distortion.

$15 Model incorporates new Kodel, Jr. unit; with large Kodel unit, $20. $15.00

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New 64 page log. Corrected sheets may be secured as changes in calls, wave lengths, owners, etc., occur. Holds 504 stations. Shows call, city, wave lengths, 4 dial settings, remarks, etc. **Tuning suggestions.** Station list by wave lengths. List by states, etc. **Trouble aids.** Other valuable information. So convenient. Worth many times small cost. Only $1. Pay postman after log and FREE map arrive. Postpaid if pay with order. **Money refunded if not delighted.** Order today—now.
RADIO PRINTERS, Dept. 3921 MARENGO, ILL.

I Want to Know

(*Continued from page* 1004)

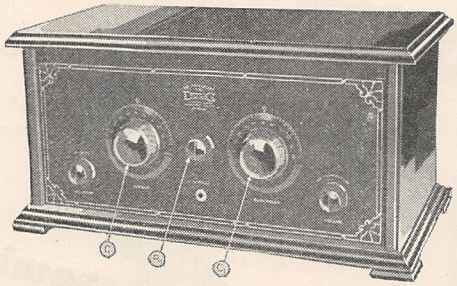
It is only necessary to reverse the connections of the two coil wires so that the coil indicates the same as with the majority. This means unassembling the coil and plug, soldering the two wires oppositely, reassembling.

Resistance R may be variable between 10,000 and 100,000 ohms.

If the circuit oscillates uncontrollably, even with loose coupling of "stator" and "rotor" it may be necessary to create a loss by reversing the connections to the mounting of "rotor."

Q. 3. How is it possible to make regenerative the Ultra-Selective receiver shown in diagram Q. 2148, appearing in the November, 1925, issue of RADIO NEWS?

A. 3. Circuit Q. 2155-B is a modification of the arrangement shown in the earlier issue.



Front view of receiver of set described elsewhere in these columns. A metal panel is one of the unusual features of this excellent receiver.

Regeneration condenser R.C. is variably controlled from the panel front and has the same value as N.C. The detector plate circuit by-pass condenser is not required. By eliminating this unit regeneration control is made better.

In the circuit of this month a semi-aperiodic aerial tuning feature is secured, eliminating the aerial condenser, loading coil L and the variability of L-2. The result of this is reduction in sensitivity and selectivity at the expense of greater ease in operation. However, selectivity and sensitivity remain very high under nearly all conditions.

The value of L-1 is determined by the maximum value of the particular variable condenser used in shunt. This is true also of unit A-B-C. Values found excellent in practice are as follows:

L-1, 59 turns; L-2, 15 turns; A-B-C, 60 turns tapped at 12 turns for A, 12 turns for B, and the remainder, 36 turns, for C. It may be necessary to vary the tapping point for N.C. one turn either way, to make neutralization easier. If 201A type tubes are used, circuit balance is more easily had, with these coil sizes. L-1 and L-2 may be wound on the same tube, with about ¼ inch space between the two coils.

We recommend a "C" battery at "X," of 1½ to 3 volts. The dotted line 2mf. condenser across its two terminals is theoretically desirable.

SELECTIVE CRYSTAL RECEIVER

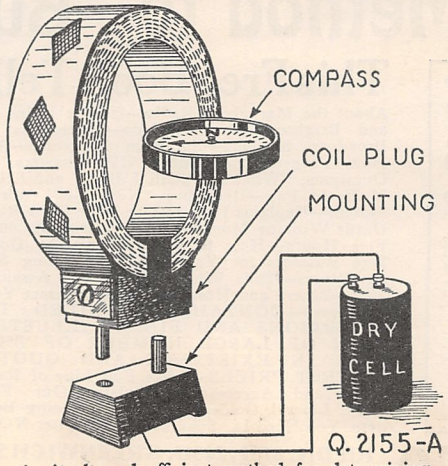
(2156) Mr. John T. Ula, Blanchardville, Wis., asks:

Q. 1. Please advise me whether the enclosed four-tube diagram will work.

A. 1. We have corrected your diagram in the manner shown.

This circuit is credited to G. N. Garrison. The object of the small coupling coils is to eliminate inductive feed-back.

The 64-turn coils are wound on 3-inch tubes. The 60-turn coil is wound on the same size tube. All four coils are spaced in non-inductive relation to one another. The coupling units are wound on 2½-inch tubes. Each six-turn coil is wound over its corresponding coil with only a single layer of



A simple and efficient method for determining whether honeycomb coils are correctly "poled."

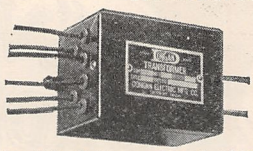
DONGAN

Transformers and Chokes Share in Big Demand for New B-Eliminators

Are you one of those radio lovers who have waited patiently for a perfected B-Eliminator? Because the new type Filament and Non-Filament Tubes have definitely answered the problem. With these tubes you can build a perfected B-Eliminator that improves your radio enjoyment more than you have thought possible.

Dongan Transformers and Chokes are important parts in the construction of these remarkable new B-Eliminators.

TRANSFORMERS

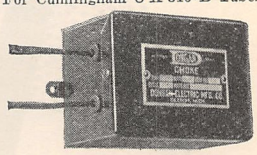


List $7.00

No. 509 Full wave For Raytheon Tubes
No. 537 Full wave For R. C. A. U X 213 Tubes
No. 537 Full wave For Cunningham C X 313 Tubes
No. 538 Half wave For R. C. A. UX-216-B Tubes
No. 538 Half wave For Cunningham C X 316-B Tubes

CHOKES

List $5.00



No. 514, 20 henry No. 506, 30 henry No. 539, 50 henry

Instructions on building your own B-Eliminator sent free on request. Dongan quality radio products at most dealers. Money orders filled promptly.

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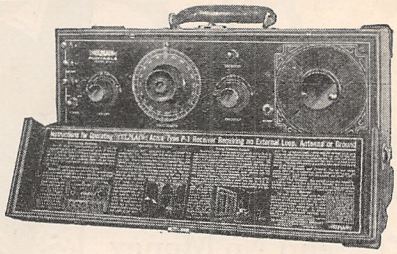
Transformers of Merit for 15 Years



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The peer of portables in size, weight, ease of tuning, selectivity, distance, volume, workmanship and price. Aerial, loud speaker and batteries self contained. Complete with tubes and batteries, $141.50. Receiver only $125.00

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Our offer of the Telmaco P-1 Receiver in kit form has met with enthusiastic reception. This contains all parts, as built by us, including case, drilled and engraved panel, and illustrated instructions. Complete kit $80.00
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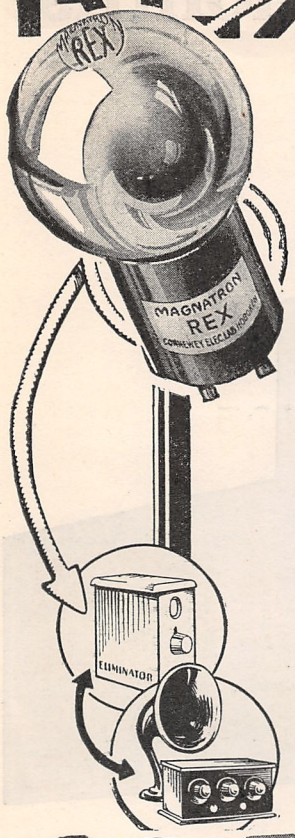
for your 'B' battery eliminator



REX answers the eliminator problem. The B Battery eliminator equipped with Magnatron Rex tubes works day in and day out—silently and economically.

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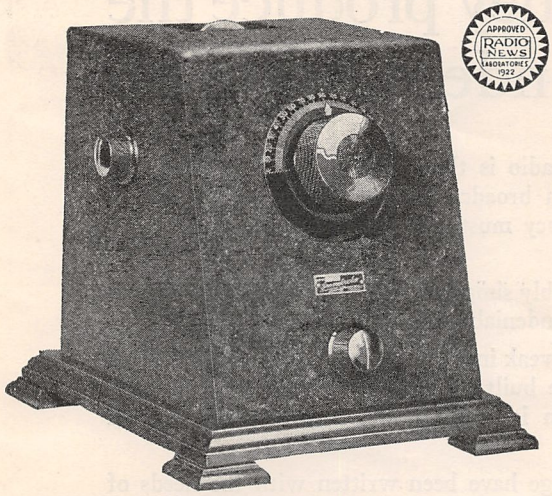

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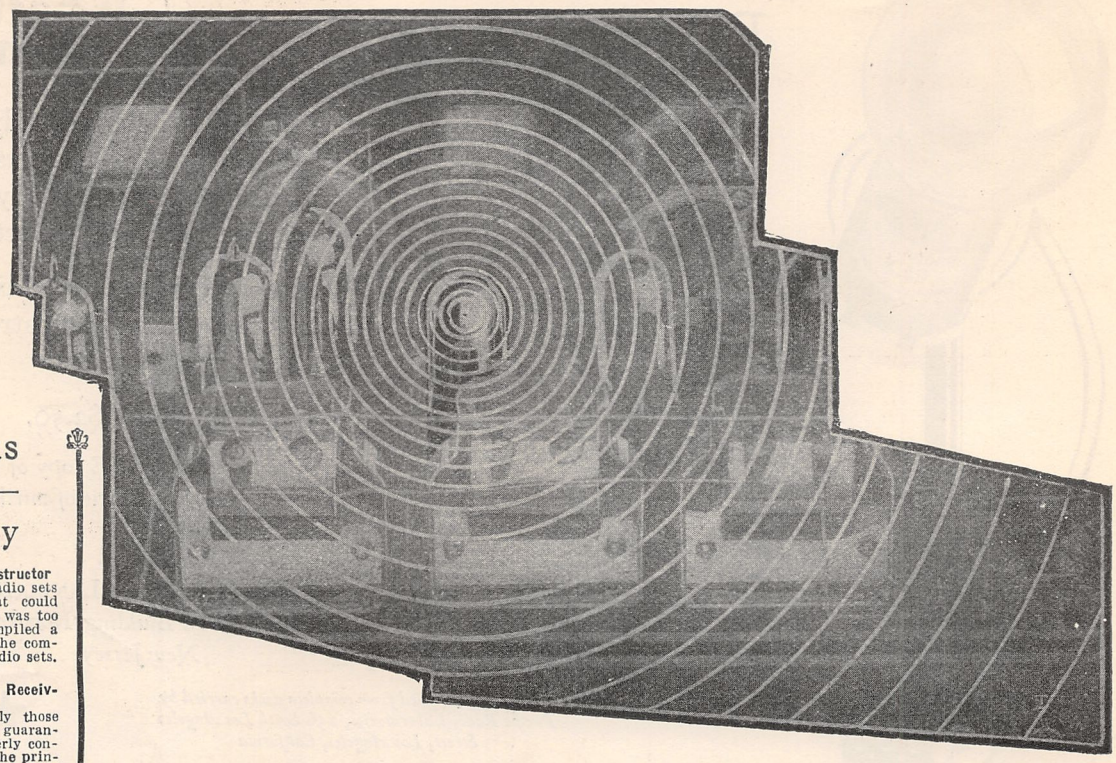

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You can get the most from this weak impulse, and preserve the full value of your set, whether it is home built or bought complete with a little knowledge of what is going on in your receivers and where to look for trouble.

The books described on this page have been written with the needs of the average radio listener in view. They are inexpensive, easy to understand and contain just the information you should have while operating a receiver.

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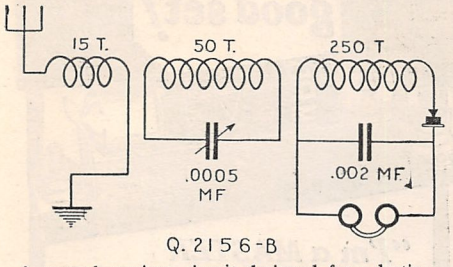
Empire cloth, or similar insulating material, separating the two.

Since a General Radio audio transformer is used in the circuit you show, we recommend that you use the secondary grid leak shown.



A crystal receiver circuit designed for selectivity. It is also the height of simplicity.

If a pilot light is used to indicate that the "A" battery circuit is closed—that the tubes are lighted—resistance R will be required to reduce the voltage to the right amount for the particular bulb used. An ordinary flashlight bulb may be used. The value of R will vary. If a four-volt lamp is used, R will have a value of about 25 ohms. Therefore, R may be a 30-ohm rheostat, and adjusted for the pilot lamp used.

Q. 2. Please give me the constants for the enclosed diagram of a crystal receiver said to be very selective.

A. 2. A single three-inch tube is used, and No. 20 D.C.C. wire. About nine inches of tubing will be required. Each winding is separated by the space of a single turn.

Q. 3. I understand it is possible to test the suitability of crystals for use in reflex receivers, by means of a 25-volt "B" battery and a milliammeter. Please give me further details about this.

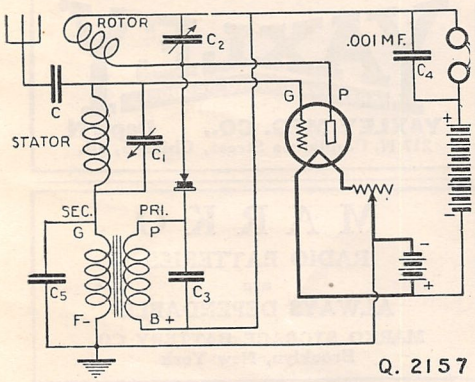
A. 3. The crystal on test, "B" battery and milliammeter are all connected in series. A suitable crystal must pass 1½ to 2 milliamperes. Reverse the crystal to determine best connection for maximum readings.

REGENERATIVE REFLEX

(2157) Mr. M. W. Thompson, Toronto, South Dakota, asks:

Q. 1. Can the enclosed reflex circuit be made regenerative?

A. 1. The changes necessary are clearly indicated in circuit Q. 2157. Condenser C-1 and C-2 may both be of 23-plate size. A standard two-coil coupler (or, a three-coil coupler with the primary remaining unused) may constitute the tuning unit. Approximately the same number of turns will be required in both stator and rotor. The stator may be wound with about 50 turns of No. 26 S.C.C. wire, on a 3-inch tube, and the rotor may be wound with about 60 turns of the same size wire. The stator is on a 3-inch tube; the rotor tube is about 2½ inches in diameter. Condenser "C" has a value of about .00025 mfd.; the exact value will vary with the particular aerial used. Any convenient ratio of audio frequency transformer may be used. The "B" potential will be 22½ volts, as usual. Try reversing the crystal detector for best results.

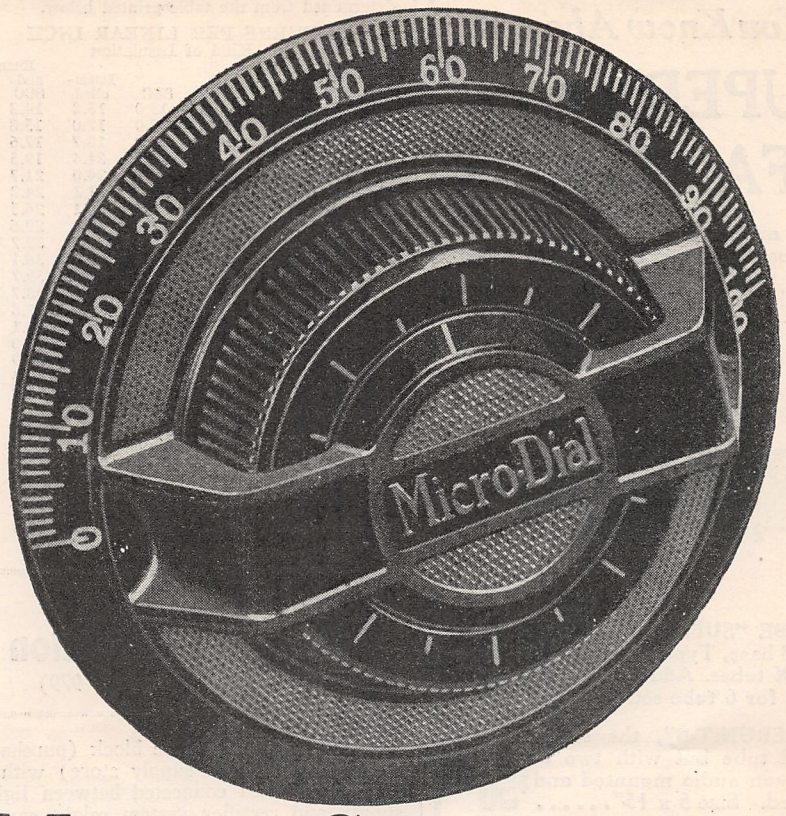


Adding regeneration to a one-tube reflex circuit of standard type. A short aerial must be used, if selectivity is a prime requisite. Any type of tube may be employed.

Q. 2. How is it possible to make a sensitivity test of a receiver?

A. 2. This is done by placing an audio frequency modulated oscillator near the receiving set and tuning the oscillator to the wave-length for which the receiver is set. The oscillator is then moved away from the receiving set. The further the oscillator can be removed from the set, the more sensitive is the receiver. The construction of such an audio modulated wavemeter is completely described in the "I Want to Know" department of the November, 1925, issue of RADIO NEWS, answering question No. 2149.

Q. 3. How many turns of No. 30 enameled wire can be wound on a tube one inch long?



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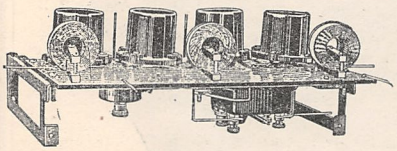

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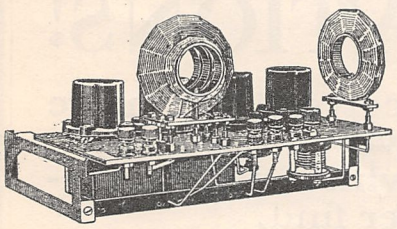

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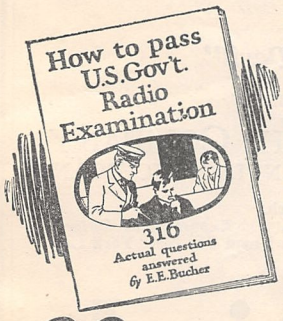

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RADIO INSTITUTE OF AMERICA
324 Broadway New York City

A. 3. The number of turns to the inch may be determined from the table printed below.

TURNS PER LINEAR INCH
Kind of Insulation

Gauge Wire B&S	DCC	SCC	DSC	SSC	Enamelled	Enamelled and SCC	Enamelled and SSC
14	13.7	14.6	14.7	15.0	15.2	14.2	14.7
15	15.0	16.2	16.4	17.0	17.0	15.8	16.5
16	16.7	18.0	18.2	19.0	18.7	17.6	18.4
17	18.5	20.0	20.0	21.2	21.4	19.5	20.5
18	20.3	22.3	22.3	23.6	24.0	21.7	22.9
19	22.5	25.0	25.2	27.0	27.2	24.2	25.8
20	24.5	27.5	27.5	29.5	30.1	26.5	28.4
21	27.5	30.8	30.8	32.8	33.6	29.6	31.5
22	30.0	34.0	34.0	36.6	37.7	32.7	35.0
23	32.7	37.5	37.5	40.7	42.3	36.1	39.0
24	35.5	41.5	41.5	45.3	47.2	39.7	43.1
25	38.5	45.7	45.7	50.3	52.9	43.7	47.9
26	41.8	50.2	50.2	55.7	59.0	47.8	52.8
27	45.0	55.0	55.0	61.7	65.8	52.1	58.1
28	48.5	60.0	60.0	68.3	73.9	57.0	64.4
29	52.0	65.5	65.5	75.4	82.2	61.9	70.6
30	55.5	71.3	71.3	83.1	92.3	67.4	77.9
31	60.0	77.3	77.3	91.6	103.0	72.8	85.3
32	62.7	83.7	83.7	101.0	116.0	79.1	93.9
33	66.3	90.3	90.3	110.0	130.0	85.6	103.0
34	70.0	97.0	97.0	120.0	145.0	91.7	112.0
35	73.4	104.0	104.0	131.0	164.0	98.8	123.0
36	77.0	111.0	111.0	143.0	182.0	105.0	133.0
37	80.3	126.0	126.0	155.0	206.0	113.0	146.0
38	83.5	133.0	133.0	168.0	235.0	120.0	157.0
39	89.7	140.0	140.0	181.0	261.0	128.0	172.0

Methods of Battery Elimination

(*Continued from page 979*)

lighting system. A fuse block (purchasable from any electrical supply store) with two 10-ampere fuses connected between lighting supply and rectifier system might save the experimenter considerable annoyance, should

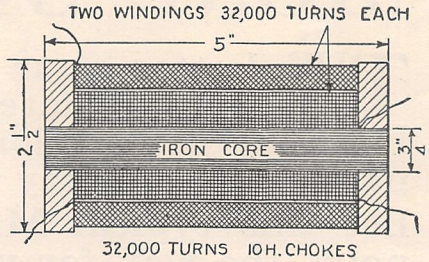

FIG. 11

This shows the construction of a 10-henry choke.

a short circuit occur, as the fuses in the fuse block will undoubtedly "blow" first.

It must be remembered by the experimenter who attempts to build an eliminator that no assurance of the efficiency of the machine can be made. It depends upon ap-

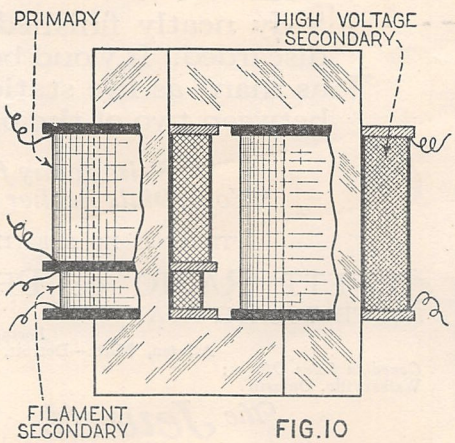

FIG. 10

Here we have the complete design of a transformer.

paratus used, values of choke coils, condensers, etc., all of which is a matter of experimenting. The circuits and "trick stunts" of battery elimination mentioned in

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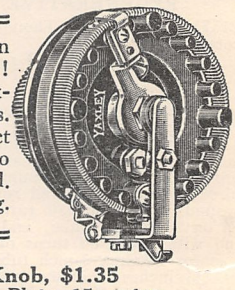

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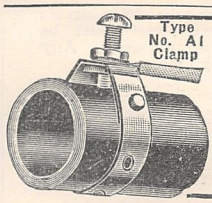

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the above paragraphs are merely suggestions which require some little additional experimenting to acquire perfection in the battery substitute.

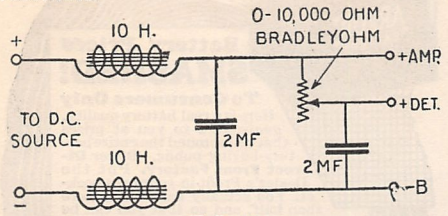

FIG. 12

"B" battery supply from D.C. supply. Provision is made for detector voltage through variable resistance.

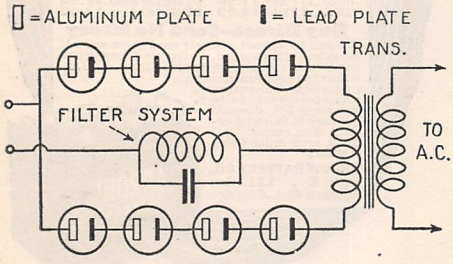

FIG. 13

Chemical rectifier system may be used for either "A" or "B" supply, or both. Larger jars and elements must be used for "A" battery current.

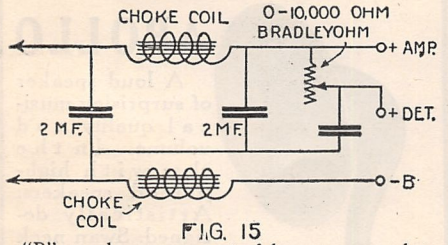

FIG. 15

"B" supply arrangement of by-pass, somewhat different from Fig. 2.

Advice to Inventors

(*Continued from page* 947)

thing had to be done, and done immediately, because it was most necessary to get that government contract.

The operator—myself—did the next best thing that could be thought of at that moment. The telephone line, a seven-mile affair and none too well insulated, was pressed into service. It worked marvelously, even if it was grounded at the opposite end. So well did it function that surprise was great. The whole force was loath to re-erect the antenna. But in those days, no station was self-respecting unless it had a huge antenna, so it was put back skyward in all its pristine glory and, as a result, reception suffered on several occasions.

The fact was that everyone put down that good reception to a freak result. As a matter of fact, it was a perfectly logical result—but it took fifteen years to discover it.

Yes, on the whole, invention is a good business and a paying one, if it is handled correctly and one is prepared to go without an occasional meal and is thoroughly in love with being considered a nut or worse. But one must have great tenacity. The job before everything. And it's usually a hard job.

He: "Now, my dear, since I've fully explained the radio set to you, are there any questions?"

She: "Yes, I am curious to know how often they read the wavemeter."

Contributed by Jack Bront.

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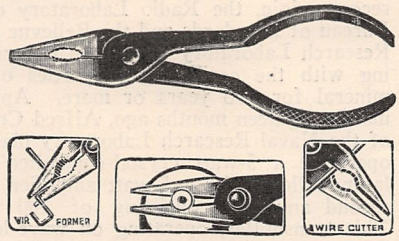

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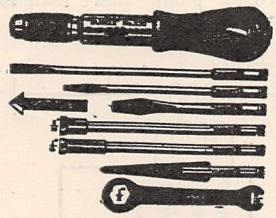

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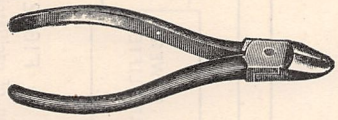

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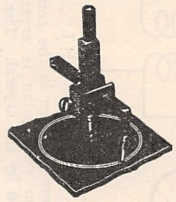

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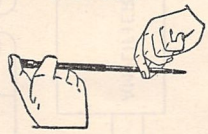

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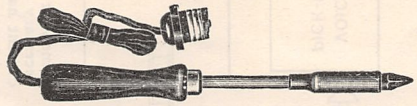

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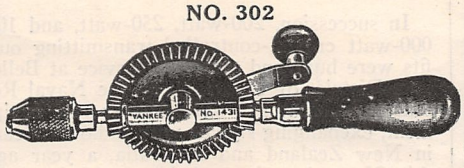

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Combination Plier, Wire Cutter, Wire Former and Wrench. Drop forged, slender but exceptionally strong. 6 inches long.
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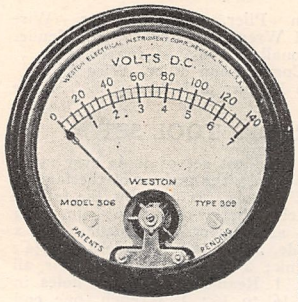

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Quartz Crystals Control Wave-length

(*Continued from page 952*)

fifth harmonic of this wave-length, which is one-fifth of a 209.9 meter fundamental, is amplified by means of electron tubes. Otherwise, a 41.88-meter wave-length crystal would be so thin and brittle as to render it advisable to mark it "fragile" when handling.

While the application of the piezo-electric crystal as a governor of the frequencies of commercial broadcast stations is of very recent origin, the Radio Laboratory of the Bureau of Standards and the Bellevue Naval Research Laboratory have been experimenting with the oscillating properties of this mineral for two years or more. Approximately eighteen months ago, Alfred Crossley of the Naval Research Laboratory placed in operation a 5-watt crystal-controlled oscillator, followed by a 5-watt amplifier and a second amplifier consisting of 100 watts. This transmitter, operating on wave-lengths between 500 and 1,000 meters, is said to be the first crystal-controlled transmitting set designed to "pump" more than 10 watts into the antenna.

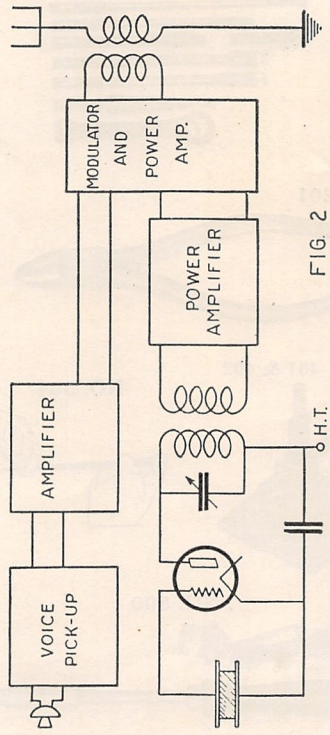

FIG 2

Somewhat different design in the connection of oscillator and modulator are necessary when the station is crystal-controlled, on account of the small current handled by the crystal. The general idea of the connection is shown in the above hook-up.

In succession, 200-watt, 250-watt, and 10,000-watt crystal-controlled transmitting outfits were built and placed in service at Bellevue, District of Columbia, by the Naval Research Laboratory. The 10-kilowatt equipment, exchanging signals with radio amateurs in New Zealand and Australia, a year ago this November, is probably entitled to the claim of being the first high-powered crystal-controlled transmitter in the world. It operates on a wave-length of 73.1 meters. More recently, the power output of this transmitting set has been increased to 12,000 watts and occasionally as much as 15,000 watts are radiated. And, insofar as information is available, this is the most powerful crystal-controlled transmitter in operation, in which intermediate frequencies or wave-lengths are used.

A one-kilowatt, crystal-controlled, radio transmitting unit maintained by the Naval Research Laboratory operates on variable

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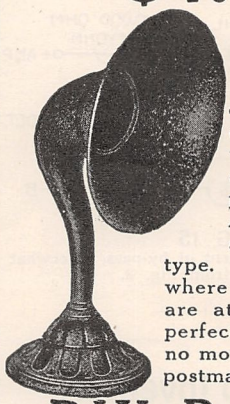

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wave-lengths—16, 20.8, 32, and 41.7. Other transmitters whose frequencies are governed by the magical properties of this mineral are 17-meter and 54-meter units. The latter set, which has flung the Bellevue call letters, "NKF," to the far corners of the earth, has been converted into a crystal-controlled outfit. Very recently this Government radio research laboratory placed in service a piezo-electric controlled transmitter operating on the low wave-length of 25.5 meters, with a power output of 10,000 watts. A 24-hour test demonstrated the efficacy of this system when, we are told, signals thus radiated were copied regularly by a radio operator in the far-away Samoan Islands.

THE "IRON PIPE" ANTENNA

The antenna used in conjunction with ultra high frequencies or low wave-lengths, when propagated by crystal-controlled transmitters, consists of an iron pipe, 30 feet long and one and one-half inches in diameter. This iron mast is placed on top of the main building at the Naval Research Laboratory. This rod is insulated from the top of the building by means of a large bowl, which also serves as a supporting base. It is guyed by use of four ropes attached to the mast near its top. A semi-circular fan arrangement of horizontally placed iron pipe acts as a counterpoise. The lead-in wire from the antenna comes through a window pane into the gallery of the building.

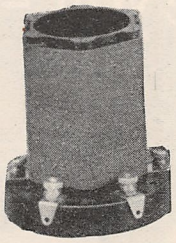
The Naval Research Laboratory is claimant to the distinction of introducing the principle of "balanced amplification" as it applies to the governing of transmitters by the piezo-electric effect. This principle is explained by analyzing the method of operation of one of the crystal-controlled units. For example, a crystal governs an UV-210 electron tube, the latter responding and oscillating at 51 meters. A 204-A vacuum tube serves as the first intermediate power amplifier, which also acts in the capacity of wave-changer. That is to say, the wave-length of 51 meters, as it comes from the crystal-controlled electron tube, is converted into a wave-length of 25.5 meters. The last stage of the amplifying system consists of a water-cooled, 20,000-watt electron tube. This is neutralized or balanced and performs the important function of amplification at a wave-length of 25.5 meters.

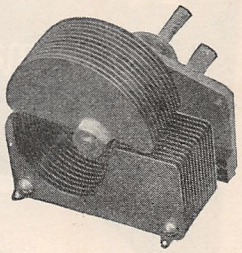
The electron tubes comprising this 25.5-meter crystal-controlled transmitter are heated by use of the 25-cycle electric current furnished by the city electric-lighting system. Power supply for the plates of the electron tubes is furnished by a direct current generator, which was first described by this writer several months ago. It is a 12,000-volt generator, the most powerful ever used for radio purposes. Though it has blown up several times and is disabled for service as this article is being written, when functioning properly, this master generator makes use of a bank of six kenetrons, delivering a power load of 50,000 watts at 12,000 volts, direct current.

The powerful, long-wave Naval station at Annapolis—NSS, operating on wave-lengths from 6,000 to 20,000 meters—has been closed down. Traffic formerly routed through this 50,000-watt arc transmitter has been diverted to a 71.3 crystal-controlled transmitter at Bellevue. This equipment includes a crystal which governs an UV-210 electron tube, oscillating at 71.3 meters, and both of the power-amplifying vacuum tubes are tuned to amplify at this particular wave-length, no frequency changing being necessary. The antenna system comprises a vertical iron rod, 50 feet high, which is supplemented by a counterpoise arrangement This transmitter has a power output of 10,000 watts, and occasionally the electric energy radiated may approach 15,000 watts

The Naval Research Laboratory recently designed and built two transmitting units for use by the Marine Corps; the frequencies of

SM PARTS





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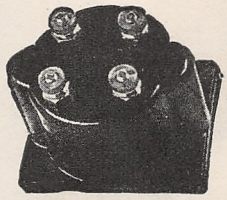

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these outfits are to be governed by the piezo-electric crystal effect. The operating wave-lengths range from 35 to 70 meters. This equipment makes use of alternating current applied to two tubes each rated at 7½ watts. These crystal-controlled transmitting sets also have a sort of Dr. Jekyll and Mr. Hyde function to perform; that is, they operate on a double frequency or wave-length—or, shall we say, that they act as wave-length or frequency changers.

USE OF CRYSTALS ON AIRPLANES

Radically departing from any previous application of the oscillating properties of the crystal quartz is the decision of the Bureau of Engineering of the United States Navy Department to capitalize the magic of this mineral for service on aircraft radio equipment. Preliminary experiments were conducted recently in the first use of crystal control in an airplane. A transmitter, employing 201-A electron tubes, the frequency of which was governed by this mineral, radiated signals on a wave-length of 28.3 meters. Dots, dashes and spaces, when thus radiated, were intercepted over a radius of 10,000 miles. This achievement foreshadows the near future when the rolling and bumping airplane will be enabled to transmit signals with a constancy of frequency not hitherto possible.

The Bureau of Navigation of the United States Department of Commerce has supplied its radio inspectors with these tiny shapes of frosted-looking glass as a means of insuring precise standards of radio afield. The Radio Laboratory of the Bureau of Standards has designed a crystal-operated portable wave meter. And, when more than 500 broadcast stations rely upon this magic mineral for maintaining their frequency standards it is estimated that 90 per cent. of the present interference experienced by radio fans will be eliminated. Certainly, it would seem, that the oscillating property of the Piezo-electric crystal is to become the accurate unit of measurement—the yard-stick, if you please—of radio.

Quartz Crystals Control Wave-Length

(*Continued from page* 953)

impressed on the crystal through the plate-grid capacity of the tube and tends to make the crystal contract. When the first impulse ceases the crystal expands and, in turn, impresses a voltage between grid and filament of the tube. The frequency of this voltage is the natural frequency of the slab and as long as the feed-back through the tube is in the proper phase relation, oscillations will build up in a stable manner. We now find that the circuit behaves much differently from that of Fig. 3. If the tuning in L1-C1 is varied we secure a change in amplitude, as would be expected, but the variation in frequency is extremely small. Changes in filament or plate voltage or load on the oscillator have much less effect than before and for practical purposes may be neglected.

The circuit shown in Fig. 4 is useful where small outputs only are required from the crystal controlled tube. If we wish to secure greater outputs the circuit indicated in Fig. 5 may be used. Here the grid leak has been replaced by a grid choke and a bias battery. This arrangement will permit outputs of 5 to 7 watts to be obtained with the use of a UV-210 tube operating at 400 volts plate potential. In order to make certain that the crystal is the sole source of frequency control in this circuit, the grid choke must be designed with a natural period that differs from the operating frequency. Tuning of the plate circuit of crystal-controlled tubes is not essential when small outputs may be used and the condenser C1 may be omitted if L1 is of the

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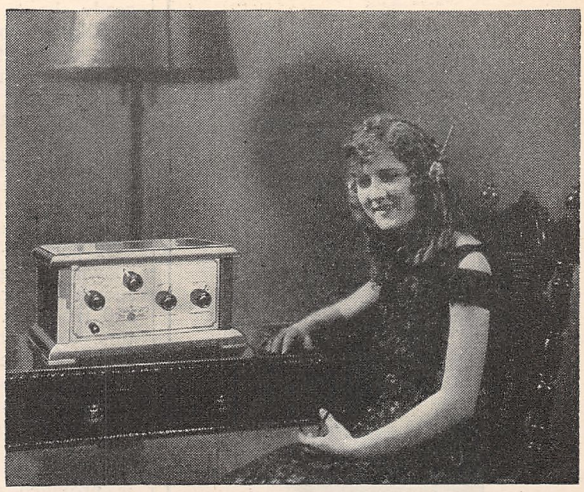

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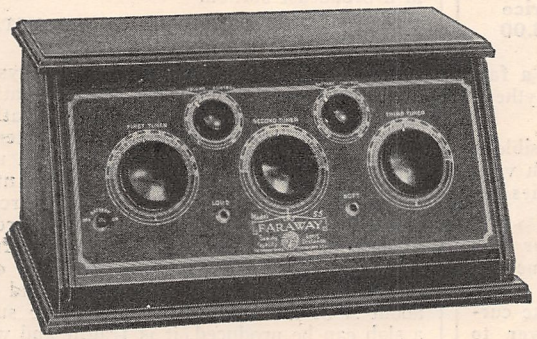

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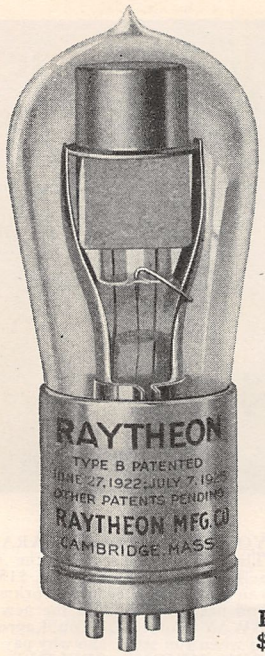

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correct proportions. The fundamental consideration is that there must be sufficient energy storage in the plate circuit to maintain a fly-wheel effect and the amplification factor of the tube must be greater than unity.

There are a number of possible modifications which may be made to the circuits already shown. The crystal may be connected directly between plate and grid of the tube, using either a grid leak or battery bias. More care must be exercised with this circuit, as the crystal oscillations may build up to such an amplitude that the slab will be fractured. A crystal which has been rendered inoperative through excessive vibration is shown in Fig. 7. The small crack in the lower left corner is sufficient to destroy its usefulness as an oscillator.

A portable crystal-controlled oscillator is shown in Fig. 6. This unit uses the circuit shown in Fig. 5 and is designed for a UV-210 tube. A variable condenser is used to tune the plate circuit and various sizes of coils may be connected in circuit in order to cover a wide frequency range. The instruments on the panel indicate D.C. plate current and circulating "tank" current, the latter being used to tune the plate circuit to resonance. An enclosed crystal mounting is provided and may be plugged into the circuit at will. A crystal-controlled oscillator of this type may be used for testing crystals, as a frequency standard, or as the master oscillator for a chain of amplifiers in a broadcast station.

EARLY APPLICATIONS OF CRYSTAL CONTROL

One of the first applications of crystal control was made on the short-wave station 2XAF at South Schenectady. This station operates on 7160 kilocycles (41.88 meters) and the usual tube circuits were found unsatisfactory until crystal control was utilized. However, a number of new circuit developments had to be carried out in order to operate with a crystal on such high frequencies. An oscillator slab ground to operate directly on 7160 kilocycles would be about .4 of a millimeter thick. While such a slab can be produced, it is fragile and will not operate easily in the average circuit. It was, therefore, decided to use a thicker slab and select one of the higher harmonics from the tube circuits. A transmitter operating on twice the frequency of 2XAF and known as 2XAD is also in use at South Schenectady. This equipment operates on 14320 kilocycles or about 20.9 meters. On such very high frequencies crystal control is essential in order to investigate transmission characteristics. The circuits used are quite similar to those on 2XAF except that after the fifth harmonic is selected the second harmonic of this new frequency is amplified. This gives a resultant frequency ten times as high as that of the crystal.

The crystal control equipment at Station WGY consists of a number of specially shielded amplifiers that furnish excitation to the main power amplifiers. The crystal-controlled tube is a UV-210 operating in a unit similar to that shown. This drives a second UV-210 which, in turn, is coupled to a UV-204-A amplifier (250 watt). The next amplifier uses a UV-851 (1 KW). Two additional stages of water-cooled tubes are then used as the final amplifiers. In order to secure successful operation all amplifiers must be carefully balanced to prevent oscillation and thorough shielding is important. It is believed that the increased frequency stability obtained when a broadcast station uses crystal control may in a large measure reduce the fading and distortion that is known to occur in some localities.

One of the first commercial stations to use crystal control is Station WIZ at New Brunswick, N. J. This station transmits to Europe and other distant points on a frequency of 6970 kilocycles (43 meters). Since

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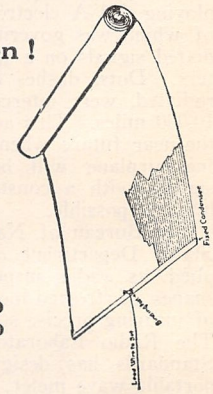

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CW transmission only is used, it is important to maintain good frequency stability as otherwise variations in the beat note at the receiving station will prevent satisfactory communication. The circuits at WIZ are somewhat similar to those at 2XAF, the crystal operating at a comparatively low frequency and a particular harmonic then selected and amplified.

OTHER CHARACTERISTICS OF CRYSTAL OSCILLATORS

Several of the less known characteristics of crystal oscillators have been investigated during the past year. One of these is the effect of shunt capacity on the crystal. It is evident that the tube itself and also the crystal mounting constitute a small condenser in parallel to the oscillator. If this shunt capacity is too great, it will prevent the slab from oscillating, particularly at the higher frequencies. Another precaution that must be observed is to keep the crystal clean. A thin film of oil, for example, on the surfaces of the crystal will impair the oscillating properties by acting as a means of damping.

The degree of frequency stability that may be obtained with oscillating crystals is of interest. It is known that temperature variations or changes in the air gap of the crystal will cause slight variations in frequency. By suitable design these two effects may be made to compensate for each other. When great precision is required, provision is made to maintain constant temperature and special mountings are used. As an example of the accuracy that may be obtained under good conditions, two 950-kilocycle crystals have been adjusted to within approximately one-fifth of a cycle of each other. The circuits and mountings previously described will permit the frequency to be maintained with less than 100 cycles variation from the required value when operating at about 700 to 800 kilocycles.

Which Type Of Coil Is Best?

(*Continued from page* 987)

the factors which determine the desirability of a coil. The electron tube which is used in nearly all radio receivers, is, broadly speaking, a voltage-operated device. The input of the tube is generally connected to the terminals of a coil. It follows, then, that the input voltage to the tube is the same as the voltage developed in the coil. It is therefore desirable that the coil develop as high a voltage between its terminals as possible. The voltage developed depends on the inductance of the coil and the current flowing through it as follows:

$$V = 0.00628\ fLI$$

in which L is the inductance in microhenries, I is the current in amperes and f is the frequency in kilocycles per second. It is evident from this that, for a given inductance, the voltage is proportional to the current and for the usual case, where resonance obtains, this means that the voltage is inversely proportional to the resistance of the circuit. If the resistance of the condenser used in the circuit is small compared with that of the coil, we may write the above equation as

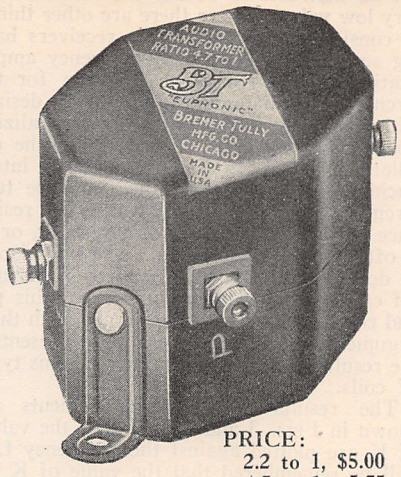
$$V = \frac{kfL}{R}$$

in which R is the resistance of the coil in ohms and k is a constant.

The part of this expression which depends on the properties of the coil alone is the ratio fl/R. The greater this ratio is, the more desirable is the coil. That is, for a given inductance the resistance must be as low as possible to obtain a high input voltage to the tube. This ratio is indicated by the symbol "K" in Fig. 3.

The value of K is, therefore, a measure of the efficiency of the coil and the greater K is the more efficient is the coil.

Ther are cases, however, where it may



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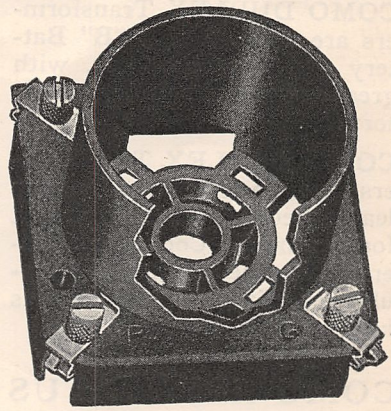

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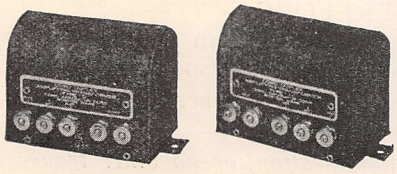

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not be desirable to reduce the resistance to very low values, where there are other things to consider. For instance, in receivers having several stages of high frequency amplification, there is a great tendency for the circuits to oscillate, and if stability is desired without employing any of the neutralizing (balancing) methods of preventing the oscillations, they can be prevented by introducing considerable resistance into the tube circuits. This intentionally inserted resistance may be in the form of a resistor, or as is often the case, the coil may be intentionally designed to have the required resistance. Of course, there are arguments for this pro and con, but we are not concerned with these arguments here. We are simply presenting the results of measurements on various types of coils.

The results of the measurements are shown in Figs. 3 and 4. In Fig. 3 the values of K are plotted against the frequency f. It will be remembered that the value of K for any coil is a measure of the efficiency of the coil. Therefore, the higher up a coil appears on Fig. 3, the more desirable is the coil from the viewpoint of efficiency.

The remarks made in the second paragraph about how rarely it happens that the cheapest is the best will now be understood by the reader. Of all the coils which were measured in RADIO NEWS laboratory, with the exception of coil No. 10 in the photograph, which is a special standard low resistance inductance used in making laboratory measurements, a simple bell-wire coil is the best. This coil is shown in a close-up photo. It is nothing more than a piece of bakelite tubing encircled by a number of turns of ordinary bell wire.

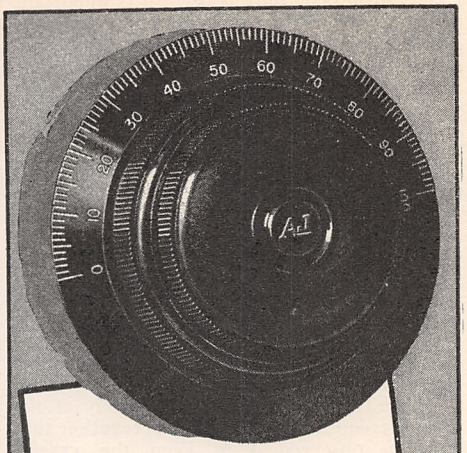
The coils fall into three groups, which overlap each other. At the top we have the solenoids. This group includes true cylindrical coils and coils of the Lorenz type, which are merely cylindrical single-layer coils, in which the turns are slightly kinked to make the coil self-supporting.

The second group includes the toroidal coils and the third and most inefficient group includes coils of the spider-web, multi-layer, paddle-wheel and honeycomb types.

Since the matter of self-capacity enters strongly into the resistance of coils, this was investigated by making measurements of the inductance of the coils. If the self-capacity of the coil is very small, the self-inductance of the coil will not change perceptibly as the frequency changes. On the other hand, if the self-capacity amounts to anything, the curve showing the relation between inductance and frequency will bend upward as the frequency increases, and the greater the capacity of the coil, the more sharply will the curve bend. The curves shown in Fig. 4 do not give any idea of what value the self-capacity may have. They simply show whether the inductance varies or not, which is a good way of determining how effective the capacity is in getting in "its dirty work." For the self-capacity has a much greater effect on the coil resistance than on its inductance, so that the more sharply the curve bends upward the less desirable is the coil from our original viewpoint of efficiency.

It will be noted that in Fig. 4 the curves included in the solenoid group are practically straight and horizontal. In other words, they do not have appreciable self-capacity. This is true even of the bell-wire coil, much to the chagrin of those who have been trying to build coils "on air" so as to reduce the coil capacity. This matter was discussed fully by Sylvan Harris in his articles on coils in the issues of RADIO NEWS, for January and February, 1925.

Many interesting things can be learned by a close study of these curves. Where one coil has a greater value of K than another, the reason can usually be understood by a glance at the form of the coil. In studying the individual coils, the following must be taken into account:



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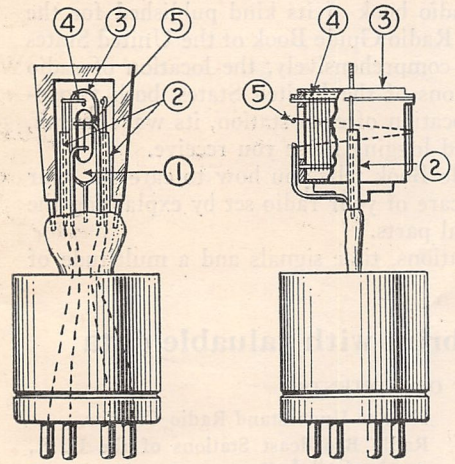
(d) The skin-effect in multi-layer coils is much greater than in single-layer coils.
(e) The effect of coil capacity and absorption or leakage in insulation is small compared with the skin-effect, excepting in multi-layer coils, where the self-capacity may become very great.
(f) To keep the physical size of toroidal coils within practical limits the diameter of the turns must be relatively small, so that many more turns are required to obtain a given inductance.

A Non-Microphonic Vacuum Tube

(*Continued from page 985*)

side of the plate is a similar arrangement for the lead to the grid. By this method any chance of these leads touching a part at another potential and so short-circuiting the elements is eliminated.

The non-microphonic characteristic of the tube is obtained through the construction of the support provided for the three elements. The grid is supported by the two wires, the ends of which show at the outer ends of the insulation strips in the ends of the plate. The filament is also suspended from supports that are attached to these same insulation strips. It is therefore evident that if the tube suffers vibration from any source whatsoever, each of the three elements will vibrate with the same amplitude and at the same rate.



Line drawings give a more accurate idea of the construction of this tube than can be obtained from the photo.

Nothing is more annoying, when listening to an exceptionally well-performed musical selection, than accidentally to jar the receiver and have a "bong" boom forth from the loud speaker. Many times vibrations are caused by something beyond the control of the operator, as the passing of heavy vehicles in the street outside, and these as well as many other causes, spoil what would otherwise be more or less perfect reproduction if it were not for the microphonic noises of the tube.

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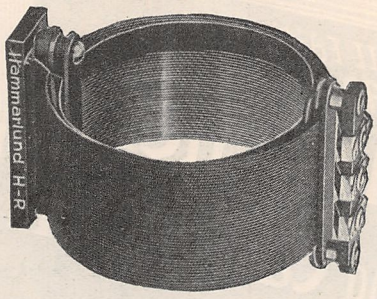

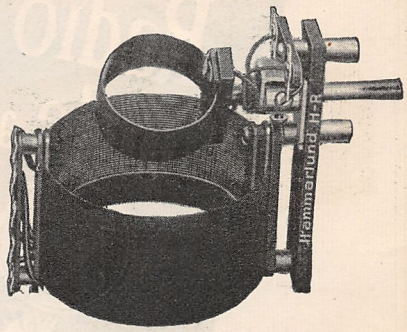

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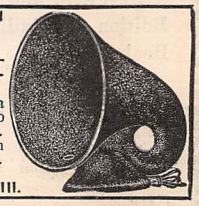

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Unraveling A Broadcast Enigma

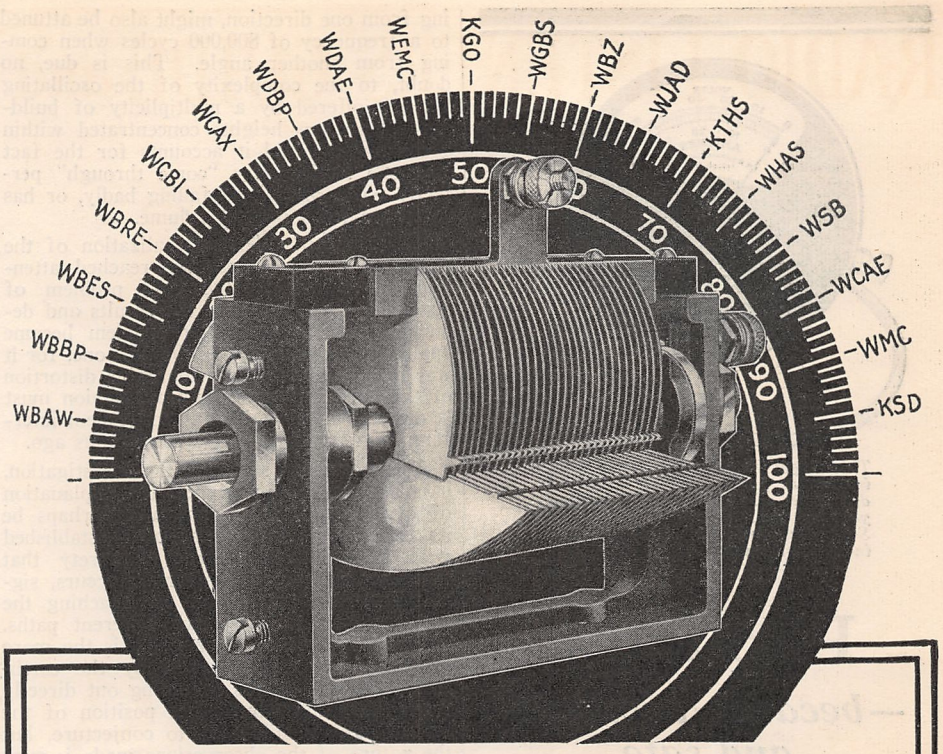
(*Continued from page 957*)

rapidly than those in the "peak" channels. For example, at a distance of 15 miles from the transmitter the peak signal might be ten times as great as the shadow signal, whereas at a distance of 30 miles the peak signal might not have decreased noticeably, while the shadow signal had become quite inaudible. Obviously, if the total effect were due to absorption alone, the signals at all points on the wave front would decrease proportionately as they traveled outward; but this is not the case.

The second definite clue came when it was noted positively that the signals at the receiving station often came from two different directions, although they originated at the same transmitting station. Furthermore, the paths taken by the two component signals were of varying length. Not infrequently, it was discovered that the received signal was composed of two inter-acting impulses, one of which had traveled more than twice as far as the other. This led the experimenters to believe that diffraction was the cause of the interference pattern, and that this distortion was of a nature very similar to that which takes place in a light wave when it passes through a block of glass at one point on its periphery, thus slowing down a portion of the wave. It is possible, of course, to attribute the phenomenon to pure reflection, by assuming that the received signal is made up of two components, one traveling direct from the transmitting station to the receiver, and the other following two sides of a triangle, being reflected from some object at the apex of that triangle. It was discovered later, however, that the two impulses were, in many cases, of almost equal intensity, making it unlikely that either could be the result of reflection; it is difficult to find a large plane reflector of radio waves that would send out a reflected wave to a considerable distance without greatly diminishing its intensity.

In short, the logical solution seemed to be refraction, resulting from a slowing up of a portion of the wave front. An examination of Fig. 1 will give some idea of what apparently occurs in such cases. When any circular wave-like impulse travels outward from a central point, a refracting substance will cause a "dent" in the wave front. As any portion of the wave travels in a direction perpendicular to a tangent at that point, the two sides of the dent will no longer travel outward in a straight line from the source, but will be bent inward toward one another, while the extremities of the dent will themselves act as new emitters of greatly weakened signals, that will apparently originate at the source of the disturbance instead of at the actual transmitter. Meanwhile, the new wave fronts originating at the two sides of the dent caused by a refracting substance will cross one another, making a more or less complex "interference pattern." At certain points the two portions of the wave will reinforce one another to make an even louder signal than would normally occur. At other portions the wave peaks of one portion will coincide with the wave depressions of the other, causing the two to neutralize one another, thus forming a dead spot. The whole effect which would occur in theory is so close to that which does occur in fact that there is little doubt of the correctness of the deductions.

A closer inspection of the main cause of the disturbance brings out the fact that the tendency to absorb energy varies with the wave-length and with the direction of the wave. That is, a building resonator, as pictured in Fig. 4, that is approximately attuned to a frequency of 1,000,000 cycles when com-



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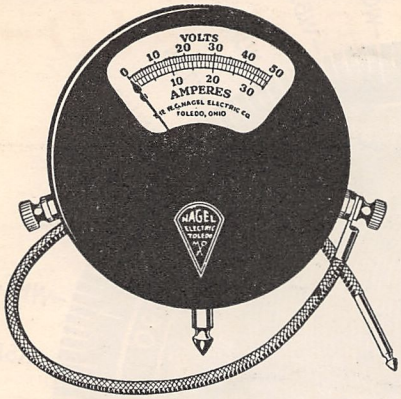

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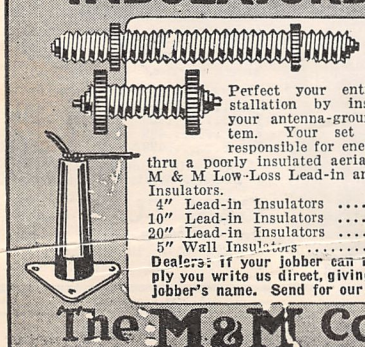

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ing from one direction, might also be attuned to a frequency of 800,000 cycles when coming from another angle. This is due, no doubt, to the complexity of the oscillating systems offered by a multiplicity of buildings of various heights concentrated within a small area; and it accounts for the fact that one station may "come through" perfectly when another is fading badly, or has decreased from normal volume.

When a fairly definite realization of the causes of the dead areas was reached, attention was turned to the twin problem of quality distortion. Here the results and deductions of the preceding problem became applicable immediately to the new one, for it was apparent that the remarkable distortion of the pure sine wave in transmission must be due to the diffraction and consequent interference referred to a few paragraphs ago.

At the present stage of the investigation, it is not possible to express the explanation of quality fading in what will perhaps be its final form; but it has been established with a reasonable degree of surety that whenever this type of distortion occurs, signals from the transmitter are reaching the receiver over at least two different paths. Presumably, one of these paths is the more or less direct one followed by the earth-bound beam of waves spreading out directly from the transmitter. The position of the second path is still open to conjecture, but the nature of the observations made is such as to leave little ground for doubting its actual existence. These observations indicate further that, in the particular case of the experimental receiving station at Riverhead, L. I., waves traveling the longer path from New York City require about 1/2000 of a second longer than waves traveling in the shorter path. The direct path from New York to Riverhead is 70 miles, so the other path was more than double this distance. Whether the longer path is due to refraction similar to that which causes the interference bands, or to reflection from the Heaviside layer, or to causes as yet undetermined, is at present uncertain. It seems, however, to change slightly in length and direction with changes in atmospheric conditions and other meterological phenomena. The direct result of reception over two paths is wave interference; and, as the longer path changes from instant to instant, the exact extent of this interference changes as well, producing a more or less gradual fading in and out of signals. But this does not account for the type of distortion which occurs in the oscillograph diagrams in Fig. 3. In order to account for these we must assume that the frequency of the transmitter is subject to small, rapid fluctuations. Thus, if we imagine the carrier frequency at a given instant to be 500,000 cycles per second, and that 1/2000 of a second earlier it was 501,000 cycles per second, it follows that at the receiving antenna there will combine the 500,000-cycle carrier arriving over the shorter path and the 501,000-cycle carrier arriving over the longer path. Although we must bear in mind the fact that these carrier frequencies are fluctuating very rapidly, we can picture at a given instant a difference between them, in this case a difference of 1,000 cycles. A few ten-thousandths of a second later this frequency difference might be 500 cycles or 87 cycles, or any other small value. These two varying frequencies would heterodyne upon one another, introducing all manner of spurious tones into the ultimately detected signal. Some such action is certainly responsible for the distortion so graphically shown in the oscillograms reproduced in Fig. 3.

As has been mentioned earlier in this article, quality distortion occurs in the vicinity of the broadcast station as well as at a distance. The above explanation is concerned mainly with conditions at points removed considerably from the transmitter.

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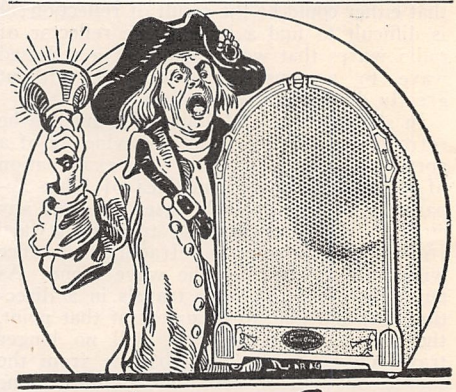

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It may be co-ordinated, however, with conditions near the station, especially in this particular instance when we are confronted with the problem of a mass of buildings that act as radio systems. It is easy to conceive of multiple reflection and refraction paths even within the city limits that would delay a signal traveling by a long, roundabout path sufficiently to cause distortion in a manner similar to that described above.

30 Years in the Dark Room

(*Continued from page* 951)

engineering subjects he could get and did a great amount of special work along the electrical line. There was very little in the actual academic schedule, it covered only the early work of Farady and some of the other early English and American investigators on the subject. His knowledge in this line was gained almost entirely from books and outside reading. This line of work he followed constantly and did the best he could.

Another difficulty here was the fact that Bethlehem was an inland town and did not offer any great facilities for such work. The necessary books had, in most cases, to be ordered from some other town. And too, there was the ever-present bugbear of the necessary money to purchase them.

From the beginning of his college work he had made trial after trial for work he could carry in addition to his regular school work in order to supplement the amount of cash he might have to spend as he saw fit himself. The college was filled with just such students and the jobs of the town were rather scarce, so the work obtained was only by fits and starts and did not last for any length of time.

Today, the course he followed would be the work usually taken by the mechanical engineering students.

Along toward the middle of his senior year he began to cast about for some work into which he might enter immediately upon the completion of his school work. There could be little if any vacation for him. Beside, he had never felt the need of one, so, as soon as the prospect of finishing school loomed in the immediate future, he just as a matter of course considered how he could best enter at once on the work he had chosen to follow for his life's occupation.

One night toward the end of the first term of the last year, he sat in a deep brown study in his room at home. He knew that he would be an engineer. That was, to his mind, settled long ago. Since the years in school with the accompanying broadening of his knowledge, he had been given a view of the real breadth of the field, and was slowly beginning to understand that it would be necessary for him to pick one special branch of the field and specialize in it.

During the last two years he had also followed pretty closely the work of the Mr. Edison he had been introduced to through the article in the *North American Review*. As he studied the problem from each angle he realized that it was the field of electricity and allied arts that he wished to enter. He knew that the field was so new that there should be a lot of room in it for the men who went into it. He thought that his knowledge of general engineering should give him some sort of a place in one of the companies engaged in the work and that through the work he could get all the practical knowledge that it was possible to obtain.

After the study had lasted some minutes and he had built many glorious air castles about the future, his work, and the whole of his life after school, once he got into actual work, he suddenly began to laugh at himself. He realized he had simply engaged

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40 m., 5MA Adelaide 850 m., CYX Mexico City 350 b., FL Eiffel Tower 2600 m., 2BD Aberdeen 495 m., PRG Prague 1000 m., PCGG The Hague 1070 m., 2FL Sydney 770 m., STOCKHOLM 440 m., HBI Geneva 1100 m., WGY Schenectady 1660 m., BRESLAU 415 m., KGO Oakland 361.2 m., CKAC Montreal 425 m., CHAC Halifax 400 m., PWX Havana 400 m., KDKA Pittsburgh 64 m., FRANKFORT 467 m., WOAZ San Antonio 394.5 m., NAA Arlington 2500 m., CHXC Ottawa 435 m., WOC Davenport 483.6.

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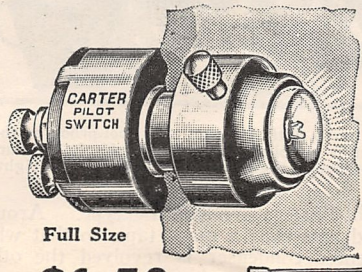

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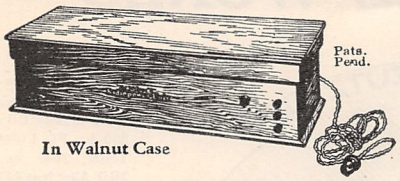

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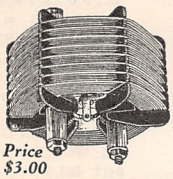
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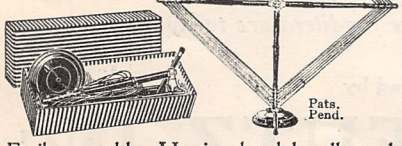

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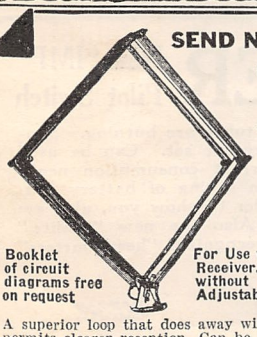

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in the study as a means of justifying his own desires. He had built the whole future of the industry in his mind just in order to show himself that the work he was about to enter was worth while.

Accordingly, having decided, after much misgiving from time to time, that the electrical industry would receive his attention, he began to look about him for an opportunity. The Edison development of the time was being carried on under the company name of the United Edison Manufacturing Company, with its general offices at Fifth Avenue near Fourteenth Street, New York. The business had been moved over from New Jersey as a matter of business policy.

Accordingly he laid his plans. A letter here and a letter there, the word of a friend and a bit of advice from older men, with railroad fare and a stout heart, were his capital when he left his home and Alma Mater after four long, hard years of work to face the world of which he knew so little.

Graduation was over. There was not so much thrill for him. Life had been pretty much the same in college as it was at home, so he did not feel the thrill that came to the others. It was simply the completion of a necessary apprenticeship which he had to serve in order to get to work.

So one bright morning in late June he set out for the railroad station and New York in search of work and life.

So began thirty years in the dark room.

(*To be Continued*)

New Developments In Radio Receivers

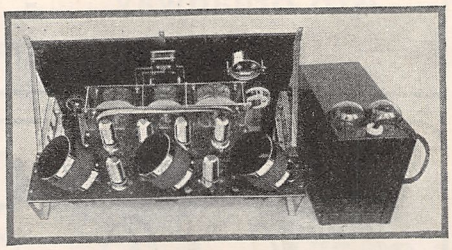
(*Continued from page* 961)

densers that are shown at the output of the rectifier tubes, which are 216-B type.

On the positive side of the rectified current is a resistance. There is a tap in this resistance and the connection to this supplies the detector tube with the correct plate voltage, due to the IR drop in the resistance. The entire resistance is used to give the correct voltage for the filaments of the tubes.

THE CIRCUIT

The first three tubes are used as those in a regular tuned radio frequency circuit, but the audio frequency stages are somewhat unusual. The condensers that tune the secondaries of the radio frequency transformers are controlled by the one dial. At the rear of these condenseres are three drums, each of which is attached to the shaft of one of the condensers, which are of the



This radio outfit is practically fool-proof, as the power is supplied from the regular house current through the power unit shown at the right.

straight-line wave-length type. Around these drums runs a metal tape, so that when the center condenser is revolved the other two follow. There is a compensating condenser which has a double stator and is used for balancing the two radio frequency stages. This is shown in the photograph above the middle condenser. The volume output of the receiver is controlled by the variable resistance in the primary circuit of the second radio frequency transformer.

The last two tubes in the set are con-

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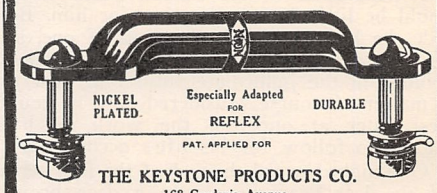

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nected in an interesting manner. The primaries of the two audio frequency transformers are connected in series and the secondaries are in parallel with the grids of these tubes. The plates of these last two tubes are also in parallel and, in the usual way, go to the high voltage positive side of the rectified source of current. This method of connection makes for excellent volume with a minimum of distortion.

The rectifier unit that is shown in one of the photographs fits inside one of the compartments at the ends of the cabinet. The filament current is controlled by the rheostat in the filament circuit of the rectifier tubes and this is shown at the left in the panel view of the set. The circuit is designed to operate with UV-199 tubes.

What Are Radio Waves

(*Continued from page 967*)

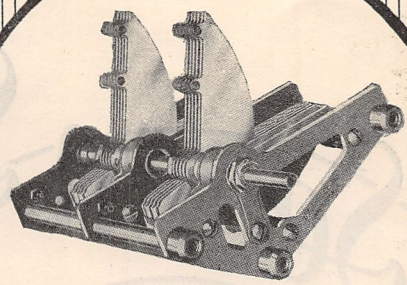
denser or about a magnet are well known. It is difficult to conceive the idea of *action at a distance,* which we have when a magnet transfers energy to another body at a distance from it, without conceiving of something going out of the magnet, traversing the space between, and entering the body. So we have constructed the lines-of-force theory, imagining the magnet to stretch out into space some sort of tentacles which fasten their ends onto the other body and in some way influence it to accept some of the energy from the magnet.

The same conception is held with regard to a charged body, as for instance, the plates of a condenser, which perchance, may happen to be an antenna and the ground beneath it. The charge on one of the plates sends out from the plate numbers of *lines of force* which traverse the space between the plates and end at the other plate. These lines of force, coming from a charged body are called *electrostatic* lines of force, in contradistinction to the lines of force coming from a magnet, which are called *magnetic* lines of force. The space containing the electrostatic lines is called an electrostatic field and a space which contains magnetic lines is called a magnetic field.

Every conductor of electricity which has an electric charge on it, has an electrostatic field about it. If the charge on the conductor is in motion (in which case there is said to be a current in the conductor) then the conductor has a magnetic field set up about it. Note that the magnetic field does not exist unless there is *motion* of the charge or charges.

The electrostatic lines of force, as shown in Fig. 3, are radial about the conductor, while the magnetic field is concentric about it. It is always found that the two fields are at right angles to each other. Furthermore, the strength of the electric field (or concentration of the lines of electric force) depends on the concentration of the charges on the conductor—which is the same as saying, when the voltage between the ends of the conductor is greatest. In the antenna, therefore, when the current ceases flowing, at the end of a cycle, the charge on the antenna is greatest, for there are no charges flowing away from it. Consequently, when the current has reached the zero point, the electrostatic field about the antenna will be a maximum. On the other hand, when the current has its maximum value, all the charge on the antenna will be flowing away from it so that the electric field will be weak, or even zero.

At the same time, we must remember that there is a magnetic field about the wire. This field, unlike the electric field, has its greatest strength when the current flow is greatest, for we have seen that the motion of the charges (or flow of current) is a requisite for the magnetic field. In other



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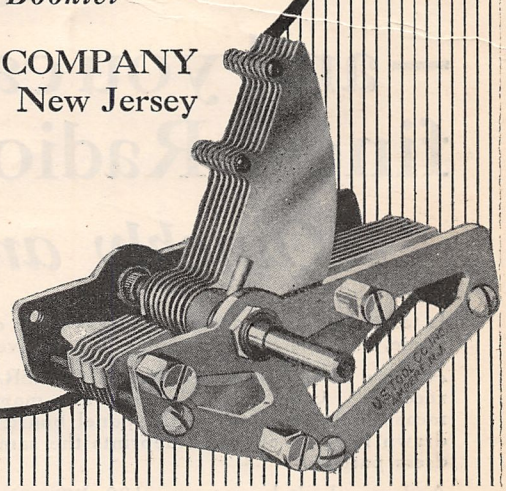

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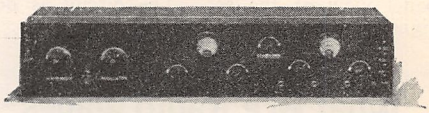

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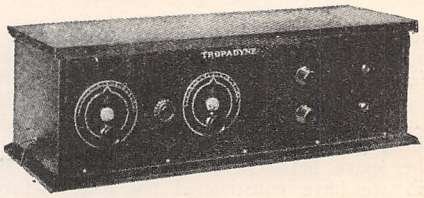

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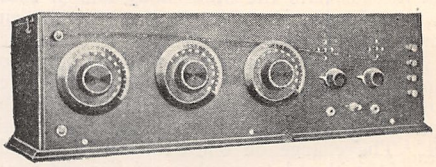

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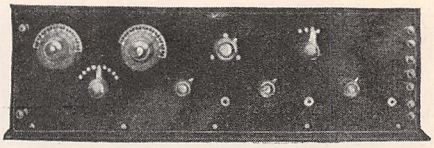

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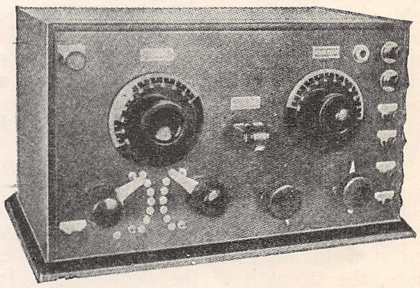

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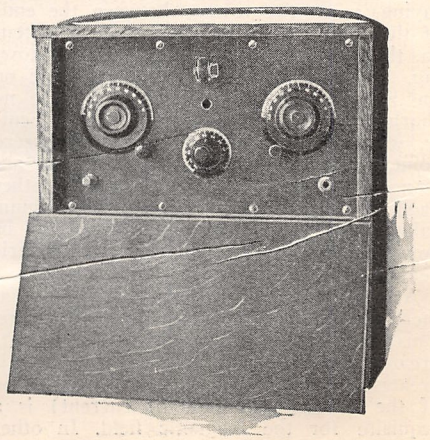

words, the electrostatic field and the magnetic field are said to be in opposite phase; that is, when one is maximum, the other is minimum; when one is increasing, the other is decreasing. There is one thing to remember in this connection, however, and that is that this magnetic field of which we are speaking is the ordinary electromagnetic field which is set up about a wire carrying a current and is the same as the magnetic field set up about any magnetized body. *It is not a true radiation field,* which we shall discuss below. It is called the *induction field.* It does not contribute materially to the radiation, as its effect is not felt very far from the antenna. The electrostatic field, which has been discussed above, is the *true radiation field,* and it is by means of this field that radio signals or concerts are transmitted. There is another magnetic field, however, which *is* a radiation field, which will be explained below.

The question now arises, "Do all circuits radiate, or give rise to radiation fields, or do only some circuits under special conditions?" It has been variously stated that open circuits, like an antenna system, are radiators and closed circuits, like a coil and condenser in series, or a circuit not even containing a condenser, do not radiate. This is incorrect; *all* electric circuits are radiators. The radiation, however, is not very great unless certain conditions are fulfilled. The first condition is that the circuit must carry alternating current. The second is that the frequency of the current must be very great to obtain appreciable radiation. The third condition is that the radiator must have considerable physical size. It is well known that a small loop will radiate, if it is carrying high frequency current, even though the loop is relatively small and is included in a closed circuit. The *amount* of radiation is the thing that is determined by the special conditions.

We have learned that there is such a thing as an electrostatic field. We also know now that this electrostatic field is formed between the plates of a condenser (or between the antenna and ground). We have also seen the effect that the stick has in creating waves, as it is moved through the pool of water. We have seen also that the more quickly we move the stick back and forth the more agitated will the surface of the water become and the more frequent the ripples. There is one other thing to consider, and that is in connection with Fig. 3. When the charges are at rest on the conductor, the electric lines of force are also at rest, extending out radially from the wire. These lines of force are supposed to have a certain *inertia,* or resistance, to any changes that may be occurring, so that if the charges on the conductor are moved rapidly, they will tend to lag behind, and consequently will have a kink or bend formed in them. If the frequency of the current in the conductor is very high, the direction of motion of the charges (*i. e.,* the direction of the current) will change before the kink has a chance to straighten out, and another kink will be formed nearer to the wire. The outer kink is therefore forced to travel outward from the wire.

In some such manner, as we have tried to explain in all the paragraphs that have gone before, an electric field is set up about an antenna similar to the field in a condenser; this electric field sets up strains and stresses in the medium between the antenna and ground and in adjoining spaces; the field is distorted, due to the frequent change of direction of the antenna current; and the disturbance is propagated outward from the antenna in all directions. There have been brought into existence two kinds of fields—an induction field which diminishes rapidly as the distance from the antenna increases, and the radiation field which contributes almost entirely to the transmission.

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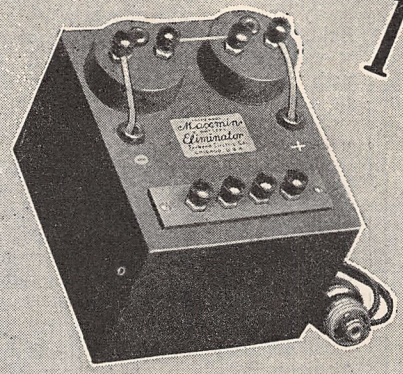

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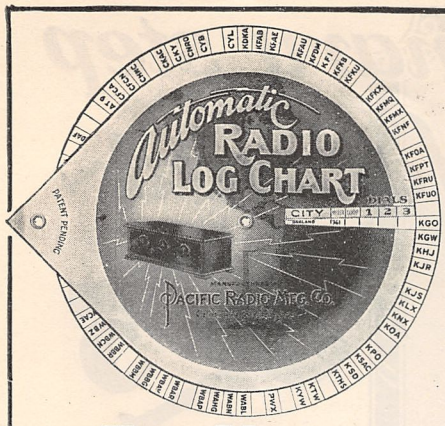

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understand. This refers to the "other" magnetic field which was mentioned above. Just as the motion of a charge (which carries an electrostatic field with it) sets up a magnetic field (induction field) about the conductor carrying the charge, so the mere motion of an electrostatic field traveling away from an antenna sets up a magnetic field, as it travels, and acts somewhat as if it were a current, setting up its own magnetic field. Also, just as when the current in a conductor has its maximum value the induction field has likewise *its* maximum value, so when the electrostatic field is maximum the magnetic field which *it* brings into existence has *its* maximum value. In other words, the radiated electrostatic field is *in phase* with its (radiated) magnetic field. Note that this is contrary to the case of the *induction field* and the radiated electrostatic field, which are in phase opposition.

Now there is something that the reader must understand and be very careful to remember, for it is on account of misstatements with regard to the existence of the electrostatic and the magnetic fields that so many misconceptions have arisen. THE ELECTROSTATIC AND MAGNETIC RADIATION FIELDS DO NOT HAVE ANY SEPARATE OR INDIVIDUAL IDENTITY. THEY CANNOT EXIST SEPARATELY. THEY ARE ONLY TWO ASPECTS OF LOOKING AT THE SAME THING. THE MATHEMATICIAN HAS BEEN ABLE TO EXPRESS *ALL* THE ENERGY RADIATED IN TERMS OF *EITHER* AN ELECTROSTATIC FIELD OR A MAGNETIC FIELD AND THE AMOUNT OF ENERGY THUS COMPUTED TURNS OUT TO BE THE SAME IN EITHER CASE, THAT IS, WHETHER WE CONSIDER ONLY THE ONE FIELD OR ONLY THE OTHER. DO NOT FORGET THAT THE TWO FIELDS REPRESENT ONLY TWO *DIFFERENT ASPECTS OF THE SAME THING.*

We have attempted to illustrate the radiation fields about an antenna in Fig. 4. Two planes are shown, a horizontal one representing the ground at the foot of the antenna, which is called the *equatorial plane* because it is at equal distances between the top of the antenna and an imaginary antenna beneath the ground, called the *image* of the antenna. It has been found that the equations of the electrostatic and magnetic fields can be worked out on the assumption that the earth has the same effect as an imaginary antenna would have, if this image is supposed equal in every respect to the actual antenna. In other words, we can suppose the earth to be a mirror. The image of the actual antenna in this mirror would be this imaginary antenna.

Fig 4 does not show this image, as it would confuse the picture. It is beneath the horizontal plane at the foot of the antenna, or the equatorial plane. The vertical plane shown in the figure represents a plane vertical to the earth passed through the antenna, which for simplicity is taken to be a simple radiating wire placed vertically.

The distribution of the electrostatic lines of force is shown in the vertical planes of Fig. 4, while that of the magnetic lines of force is shown in the horizontal or equatorial plane. In these figures the fields are strongest at the places where the lines are congested and weakest where there are fewest lines. It will be noted in these diagrams that the strong and weak points in these two fields coincide where the planes intersect. This agrees with the statement made above that the electrostatic and magnetic *radiated* fields are in phase. The induction field is not shown in these diagrams, as it would be too small to show on the scale used. We must imagine these diagrams to represent perhaps several hundred feet in either direction. Furthermore, the induction field rap-

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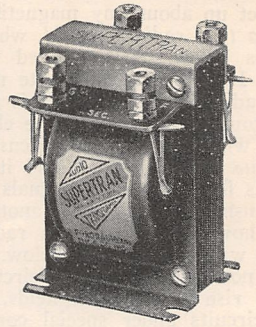

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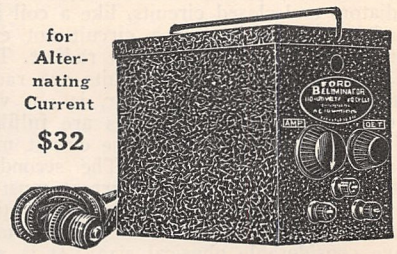

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idly diminishes to a negligible quantity at a very short distance from the antenna.

The four diagrams show how the field changes as the current in the antenna changes. The first diagram shows conditions when the antenna current is maximum. The charge on the antenna is zero and there are no electric lines of force emanating from the antenna. The fields shown are supposed to have come from a previous charge on the antenna. The strength of the fields at various distances is indicated by the curves A and B, A representing the field strength of the electric field, and B the strength of the magnetic field. The curves marked "voltage" and "current" below the diagrams represent the conditions of current and voltage in the antenna at the same instant.

CURRENT DECREASE

The second diagram in Fig. 4 shows conditions a little later, when the current in the antenna has begun to decrease, and the charge has begun to increase. Lines of electric force are now coming from the antenna, and the lines already in existence have moved outward a little. The conditions shown are for an instant one-eighth of a cycle after the instant of the first diagram. After another one-eighth of a cycle the current in the antenna has decreased to zero, and we have the condition of maximum charge. A great number of electric lines of force are being radiated now. The fields have moved a little further from the antenna.

Now, an eighth of a cycle later than this (fourth diagram of Fig. 4) the current in the antenna is increasing but in the opposite direction. That is, the polarity has reversed. The electric lines of force then suffer a contraction into a kidney-like shape and snap away from the antenna, joining the rest of the moving field. All the while the two fields are moving outward from the antenna, at all times perpendicular to each other, the magnetic field being parallel to the ground and the electric field being perpendicular to the ground. At the same time it will be noted that both fields are at right angles to the direction of propagation of the waves, that is, the direction in which the waves are moving. These various directions are illustrated clearly in the little diagrams marked E, M and C. E represents the direction of the electric field, M that of the magnetic field, and C represents the direction of propagation.

PERPENDICULAR FIELD

At great distances from the antenna the electric field becomes exactly perpendicular to the earth, for the waves then become parts of circles with infinite radii.

In all that has gone before, the assumptions have been made that the antenna is placed in a perfectly non-conducting medium, and that the ground to which the radiated waves are attached has infinite conductivity. In other words, we assume that the antenna is a perfect one in every respect and that the ground is likewise a perfect conductor. We all know that such perfect things do not exist, so that to account for changes in these conditions the theory must be modified. In another article we shall explain how the radiation fields vary in shape and distribution for various actual conditions, including cases where the ground is a poor conductor, where there is ionization around the atmosphere, and where there is absorption in the earth, and many other things.

The foregoing should give the reader a fairly clear idea as to the exact nature of radio radiation—the energy which carries the broadcast program through space.

Next month we hope to present a further discussion of this type dealing with loop and antenna reception and possibly some notes regarding the Heaviside layer and the part it plays in radio.

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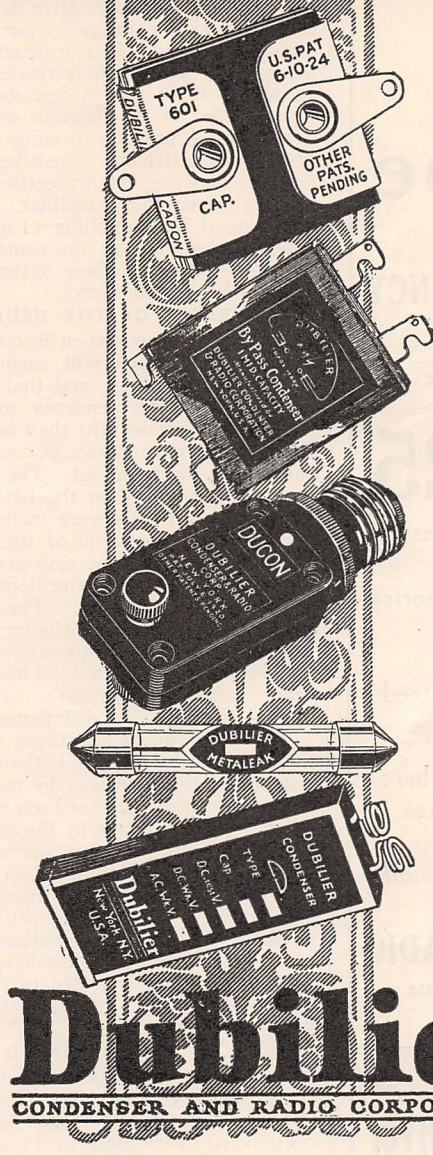

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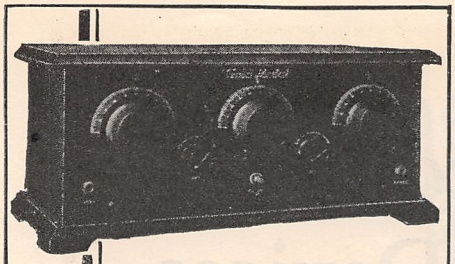

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Gives Tones Equal to Resistance Coupling

A Single Control Regenerator

(*Continued from page 974*)

current in the tubes is shown next to the antenna coupling coil. If it had been desired, this might have been eliminated, and ballast resistances or amperites might have been used in its place.

In the next issue of RADIO NEWS, a circuit will be described in which an automatically controlled regenerative detector will be combined with a radio frequency amplifier. This is a feat which is ordinarily difficult to accomplish, but which is rendered relatively simple when the system described in this article is used in the detector circuit. It will, therefore, be possible to enjoy all the benefits of the extremely sensitive regenerative detector and the distance-getting qualities of the high frequency amplifier. Probably the best type of R.F. amplifier to use is the neutralized type, such as the neutrodyne or the Isofarad. Both of these systems have been described in RADIO NEWS.

REVERSAL OF THE USUAL TYPE

There is a phenomenon in connection with this receiver which will surprise many of those who try it out, and that is that there is slightly greater tendency to oscillate on the longer wave-lengths than on the shorter. This, as everyone knows, is contrary to what happens in the usual set. The reason for it is easily explained on the basis of the approximations which were made in outlining the theory of operation of the receiver.

In the first place the resistance of the secondary loading coil was neglected, as well as its distributed capacity. The coil capacity causes the inductance to change with changes in wave-length or frequency, so that tuning will be slightly affected. This, at the same time, changes the resistance of the coil, due to the effects of the distributed capacity.

The most important thing which affects the operation of the set is the change of resistance of the condenser by means of which the set is tuned. As has been explained elsewhere in RADIO NEWS by the writer (March, 1925), the resistance of a condenser is greater at the low dial settings than at the high. For this reason, when tuning in on the shorter wave-lengths, the resistance of the circuit is more than neutralized, due to this extra resistance in the condenser. In other words, resistance is added to the circuits at a slightly greater rate than the square of the frequency.

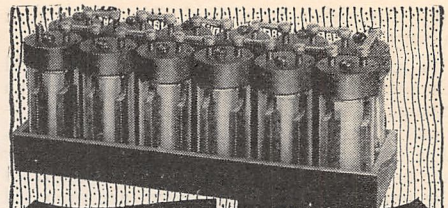
BROAD TUNING

A happy combination of shunted resistance, tickler coupling, etc., can be secured, however, which will make the set operate continuously very close to the point of oscillation.

The set is likely to tune broadly if it is not adjusted properly, but when the adjustments are right, it will be found to be an ideal receiver for short-distance reception. It will bring in distant stations, however, for it is rendered very sensitive because of the regeneration, which does considerably more than merely make up for the decrease in sensitivity due to the resistance added to the input circuit. The greatest advantage of the set, however, as will be shown in following issues of RADIO NEWS, is the ease with which it may be successfully adapted to a radio frequency amplifier.

WATCH YOUR AERIAL

The necessity for exercising care in the construction of the antenna has been recognized by everybody who knows the least bit about radio reception. Good-sized wire should be used, and all joints should be carefully soldered. Poor joints in antennas often account for poor results obtained, the blame for which is often fixed on the design or construction of the receiver. Do not forget that the antenna is as important as the set proper.



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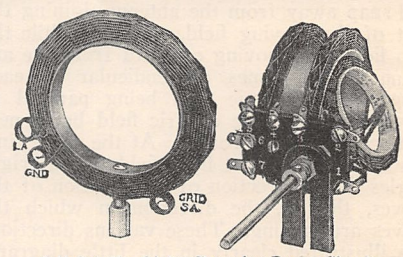

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1845 Broadway New York City

The Cathode Ray Oscillograph in Radio Work

(*Continued from page 989*)

rent rises and falls and thus traces out a "dynamic characteristic" on the fluorescent screen.

Fig. 5 represents one of the latest commercial types of cathode ray oscillographs. These instruments cost about eighty-five dollars. They have so many applications in radio work that a small book would be required to describe and explain all of them. In much of the work a camera is called into play to photograph the luminous figures and thus obtain a permanent record. In some of the more complicated forms of this instrument a photographic plate is introduced into the evacuated chamber so that the cathode ray beam falls directly on the plate. For all ordinary purposes, however, the type pictured in Fig. 5 is the best and easiest to use.

RADIO FREQUENCY AMPLIFIERS

The average radio fan generally becomes bewildered when he reads the advertisements in the radio periodicals showing about steenteen million five-tube sets having two stages of R.F. amplification. Each one is claimed to operate on a different principle and each one is supposed to be better than the others. To clear up this haze it is well to begin to generalize.

The radio frequency amplifiers in these outfits may be classified somewhat as follows:

(a) **R.F. amplifiers which are designed to be so inefficient that they will not oscillate at any wave-length.** It will generally be found that the interstage coupling coils of these tuners are made of very small wire so as to have high resistance. Furthermore, there are but few turns on the primaries of these coils, so that the energy that can be transferred from the primary to the secondary is relatively small.

(b) **R.F. amplifiers identical to those under (a) in which the efficiency is increased by means of feed-back or regeneration.** One method of causing this regeneration is to use a potentiometer. Another method is to use a tickler coil, in any one of the stages, in each of them, or to cause feed-back from the plate circuit of one stage to the grid circuit of another.

(c) **R. F. amplifiers which are made efficiently, but have a tendency toward self-oscillation.** In these amplifiers self-oscillation is almost the normal thing; the problem in this case is to prevent self-oscillation. This is exactly the opposite of case (b) above. One way of accomplishing this is to place resistance in the grid circuits of the R. F. amplifiers. Another way is to provide feed-back coils as in case (b), but here the polarity of the coils is reversed.

(d) **R.F. amplifiers which are designed efficiently, but in which the difficulty attending feed-back currents has been eliminated by "killing" these currents.** This is done generally by means of neutralizing condensers, but may be also done by means of neutralizing inductances or resistances, or combinations of these.

The results obtainable with the classes of amplifiers described under cases (b) and (c) are about equal. Results obtained with those under (a) will, of course, be inferior, because no attempt is made to correct for the poor design. There is an advantage obtained in (a), however, which is that these receivers will never radiate and cause our neighbors any annoyance.

The neutralized amplifiers will probably give the best results under most conditions. If the neutralizing has been done properly, there will be little or no chance of radiation.

An overnight charge with a Tungar costs about a nickel. It peps up both "A" and "B" batteries and keeps your radio set at its full-toned best.

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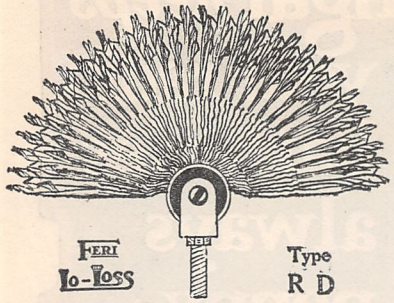

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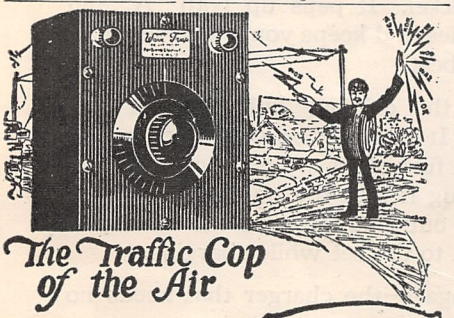

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See the new Ferbend "B" Eliminator announcement on page 1083

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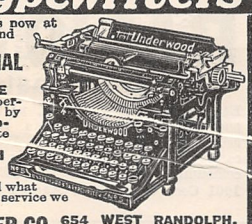

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Navy Investigates Ultra-Frequencies

(*Continued from page* 955)

4,000 miles. It is known, however, that the missing region or the jump in this frequency is very great at night, both summer and winter. Very little exploration has been made here, but there is some data indicating that this frequency can be successfully used at 10,000 miles, even at night. This statement is based on the establishment of two-way communication with Australian 2-CM (Sydney). He used 21 meters and this station used 20.8 meters, between 1 A. M. and 2.30 A. M. E.S.T. It was broad daylight when the test commenced. It should be noted at this point that this laboratory has so far, not used more than 750 watts in the antenna in the twenty meter band. Australian 2-CM was using still lower power. It is evident then that figures estimated for 5 k.w. in the antenna but actually based on experiments with less than 1 k.w., ought to be fairly conservative.

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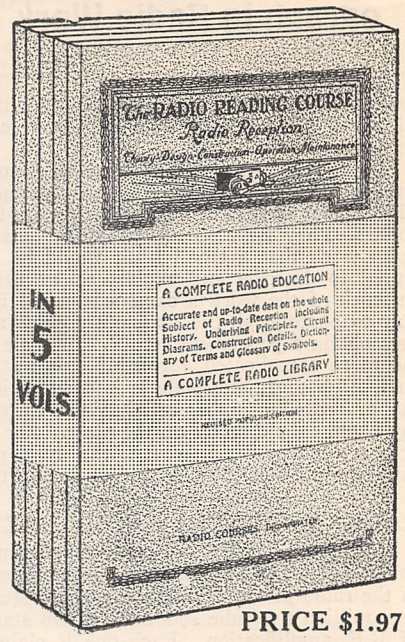
TUNE IN ON WRNY

At 20,000 kilocycles the exploration is very scanty indeed, but there is information at hand giving the distances of the daylight jump as in the neighborhood of 1,500 miles with an uncertain region extending to 2,500 miles and which probably is followed by a certain region for a considerable distance beyond. Absolutely nothing, however, is known of night ranges on these frequencies. The ranges of the direct, or earth-bound components are well enough known; they are about 60 to 70 miles for 15,000 kilocycles and in the neighborhood of 40 to 50 miles for 20,000 kilocycles.

It is not the purpose of this particular report to go into details of the vast amount of information upon which the range chart is based, nor to divulge at this particular time the theory which is gradually forming in the minds of the engineers of this laboratory which we believe will account for these curious effects. The purpose of this report is to serve as a practical guide to indicate what ranges may be covered at different frequencies and what ranges remain to be explored, and what we hope to get in the unexplored regions.

It may be stated at the present time, however, that some of the most valuable information confirming earlier data on the matter of the "skip" or "miss" region was obtained from the daily reports made by Major J. O. Mauborgne, U. S. A., from the Army transport *St. Mihiel*, who took observations on 16, 32, 20.8 and 41.7 meters, all the way from New York to Panama. It is believed that the information concerning



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the uncertain regions and "skip" regions is fairly definitely known for daylight work. If any special criticism could be made of the range chart it would be that it underestimates the summer night ranges on 3,000 kilocycles.

When one considers the chart as a whole, the high frequencies show clearly their enormous superiority from a point of view of economy on power consumption and general cost, and further it is possible to obtain ranges with high frequencies which we cannot hope to equal with almost any practical amount of power on lower frequencies.

EAST AND WEST COMMUNICATION

To apply the chart to east and west communication, we must, for the present, consider that during the hours when daylight obtains over the entire stretch, we apply the daylight range data. For the hours which night obtains over the entire stretch, we apply the night data. In the intermediate hours when part is sunlit and part dark, much further exploration will have to be made, but we do know that a sort of compromise condition does exist and it does appear further that a 5-k.w. transmitter, equipped with about four frequencies would be in a position to obtain highly creditable ranges at any time of either day or night, and whether for north and south communication, or for east and west. We must, however, at present, until further information comes in from stations like Samoa, Guam and Cavita, be forced to believe that the east and west problem is more difficult of practical solution.

It must be understood in referring to the range chart, that estimates on range and reference to the "missing" of "skipped" areas on the higher frequencies refer in the case of the daylight ranges to conditions existing in the middle of the day and for the night ranges, to conditions existing in the middle of the night. For west and east work this must be interpreted as meaning conditions when the sun is half-way between the two meridians under consideration. It is well known, of course, that there is a more or less gradual transition from daylight to dark conditions; in fact, it is not nearly as abrupt as one would anticipate it to be, especially in the summer time.

Since the first part of this report was written Samoa has reported successful reception of our 20.8 meter wave as early as 8 P. M. zone plus five time, which means that 6,000 out of the 7,000 miles between Washington and Samoa were traversed in

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List of Radio Articles Appearing in the January Issue of "Science and Invention"

Concentric Versus Eccentric S. L. F. Condensers. By William M. Henderson.
An All-Around Broadcast Receiver. By A. Dolid
Three Tubes Do the Work of Four. By Sidney E. Finkelstein, Asso. I. R. E.
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A Professional Operator.

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"I followed your advice and put in another coupler instead of a transformer. I'm more than pleased. No more transformers for me! Your method of amplification is better, cheaper, and easier to assemble than any other."
From the Mid-West.

"Yesterday I got another Daven Unit and hooked it up. It would take some PULL to pry it away from me. Have a *regular* set now. I fail to see how anyone can stick to transformers after hearing music come through your way."
A Satisfied New Yorker.

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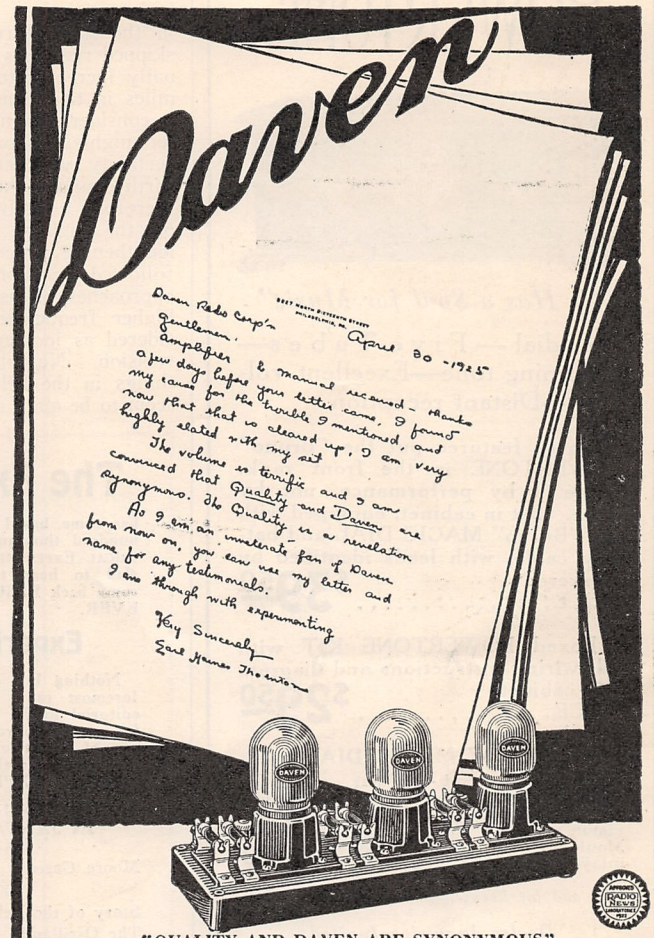

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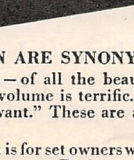

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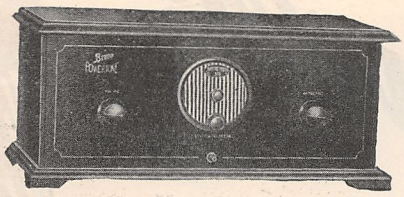

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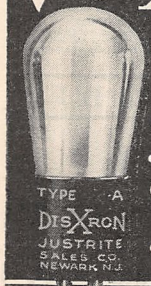

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daylight. Also it is well known that 20 meter signals from amateurs on the west coast are now received as late as midnight or 1 A. M. zone plus five time, which could not have been done during winter nights. This is interesting as showing a gradual change in the skipped region for 20 meters. The skipped region is less in the daytime, gradually increases to somewhat less than 2,000 miles in the summer nights and very likely is considerably in excess of this in the winter nights, although it is not known with certainty whether it ever comes down to earth again in the winter nights. One must therefore conceive of the skipped distance on the higher frequencies undergoing a lengthening process as the night wears on, followed by shortening process as daylight approaches. Most of the information on the higher frequencies must of course be considered as incomplete and subject to future revision. Nevertheless certain fundamental things in the behavior of these frequencies seem to be quite definitely established.

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has come back! If you are one of the one hundred thousand readers of the old ELECTRICAL EXPERIMENTER, you will no doubt be glad to hear that the EXPERIMENTER has come back BIGGER AND BETTER THAN EVER.

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INTERESTING ARTICLES TO APPEAR IN JANUARY ISSUE OF THE EXPERIMENTER

Moore Gaseous Conductor Lamp
By T. O'Conor Sloane, Ph.D.
Story of the Bell Telephone
The Oscillaud By Harry R. Lubcke
The Evolution of the Vacuum Tube (Part II)
By Leon L. Adelman, A.M. I.R.E.
A Low-Powered Transmitter
Laboratory Chemicals from Common Sources
By Earle R. Caley, M.Sc.

The EXPERIMENTER will be on sale at all newsstands December 20, 1925.

Balboa reports satisfactory reception of our 20.8 meters throughout the 24 hours during the summer but it is not anticipated that this will be possible in the winter time. Very likely the signals as received at Balboa will fade out during 6 or 7 hours during the winter nights. At the present time the 20.8 meters with less than 1 k.w. in the antenna is more satisfactory for handling traffic with Balboa than Annapolis on 17,000 meters.

SUMMARY

A preliminary range chart has been constructed for telegraphic communication, 5 k.w. in the antenna, at various frequencies. The conclusions upon which the range chart is based, are derived from experiments made by the Naval Research Laboratory, from experiments made by amateurs and upon such data as the Laboratory has had access to from commercial and Government sources at home and abroad.

An attempt has been made to indicate in a general way the advantages and disadvantages of high frequency telegraphic transmission. Various critical regions are pointed out where new phenomena make their appearance: in particular these regions are (1) the region between 2,000 and 3,000 kilocycles where daylight ranges begin to increase with increasing frequency at the same time that the night ranges show extremely great increase and a degree of reliability which would be wholly unantici-

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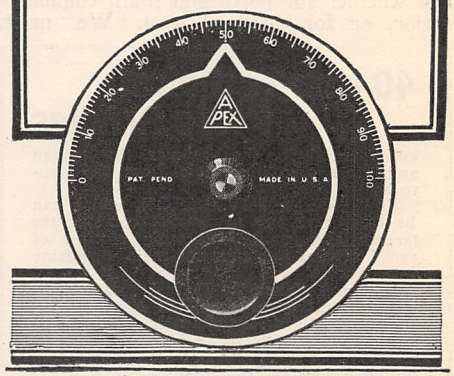

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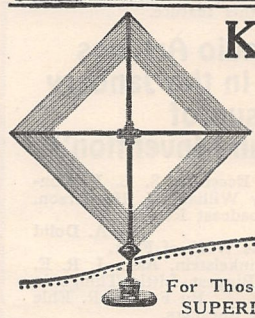

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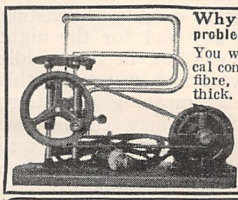

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pated from observations made at frequencies lower than 2,000 kilocycles. (2) A region around 6,000 kilocycles where an uncertainty develops during the winter nights at relatively very short ranges. (3) The development at successfully higher frequencies of this uncertain range into the missing region which is most pronounced in the winter nights, and finally as the frequency is increased makes itself felt in the summer nights and at still higher frequencies even in the daytime.

The development of this missing region to extensive areas is shown to take place with frequency rise to 20,000 kilocycles. The chart also attempts to indicate in a general way, the region of uncertain communication and the regions where further exploration is urgently needed. It is quite evident that the range data is far from complete and that many individual cases will be found in contradiction to the chart, but it does represent a sort of general average of the situation as it presents itself to the engineers in the Naval service.

It is hoped that the publication of this data will promote useful discussion and collaboration in this new and interesting field. The data would, no doubt, have to be modified materially to make it apply to any highly directive system of transmission.

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ARTICLES IN JANUARY ISSUE

To California and Back, By Mrs. C. L. Nixon.
Yosemite, By Chas. W. Geiger.
Tourist Camping in Southern California, By Ernest McGaffey.
By Motor Along the Kings Highway, By May L. Bauchle.
Variety in California, By Louis L. Thomas.
California Redwood Highway, By Chas. W. Geiger.
Westward Ho, Mary B. Steyle.

REPORT ON RECENT RADIO CONVENTION IN WASHINGTON, D. C.

A comprehensive program of legislation that would amplify in many important particulars the existing radio regulations of the Federal Government was approved at the closing session today of the Fourth National Radio Conference for transmission to Congress for action this winter.

A declaration against monopoly in broadcasting and a pronouncement that free speech over the radio shall be held inviolate are outstanding features of the program. The conference also recorded itself as opposed to any form of Government censorship.

Recommendations were made that in supervising radio the authority of the Secretary of Commerce should be limited to the issuance of licenses to broadcast, the control of power, the assignment of wave-lengths and other appropriate measures applying to the interstate and international situation.

It was expressly stipulated that governmental authority should not be extended to mere matters of station management except insofar as such management might interfere

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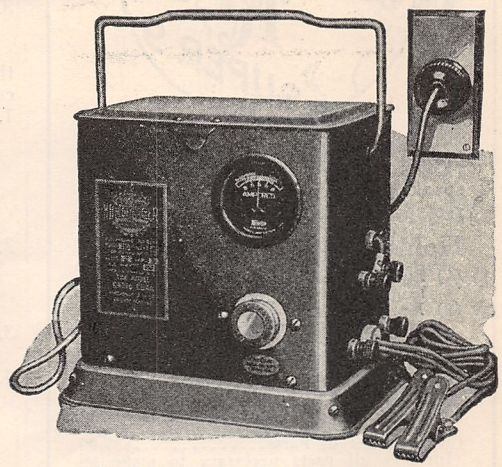

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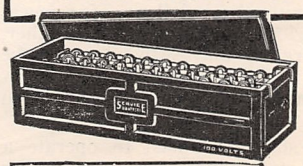

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Indestructible rubber case. Two year guarantee.
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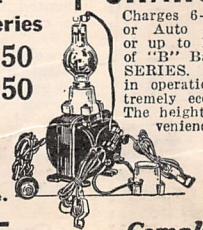

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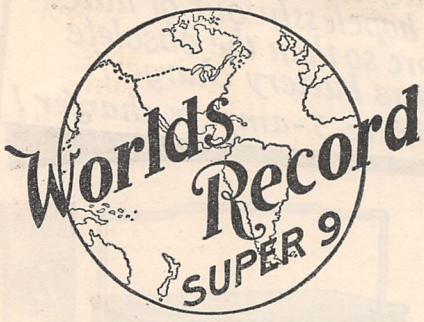

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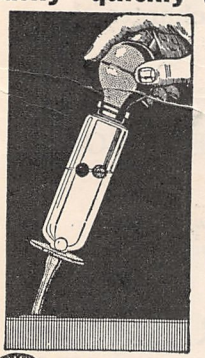

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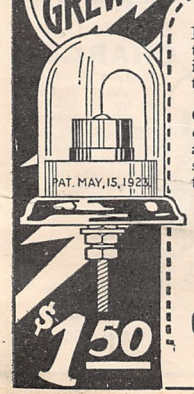

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with an orderly dispatch of traffic in the air channels.

SUMMARY OF THE PROGRAM

The legislative program was summarized as follows:

1. Existing Federal statutes are inadequate to permit proper administration of radio communication activities.
2. The Congress of the United States is empowered by the statutes to enact legislation necessary to provide such adequate administration.
3. Present conditions and the public interest require that such legislation be enacted.

Your committee therefore recommends that Congress do enact such legislation incorporating therein the following principles:

1. That the administration of radio legislation shall be vested in the Secretary of Commerce, who shall make and enforce rules and regulations necessary to the proper administration of the provisions of such legislation.
2. That such administration shall be exercised by the Secretary through the officers or employes of the Department of Commerce.
3. That the doctrine of free speech be held inviolate.
4. That those engaged in radio communication shall not be required to devote their property to public use and their properties are therefore not public utilities in fact or in law; provided, however, that a license or a permit to engage in radio communication shall be issued only to those who in the opinion of the Secretary of Commerce will render a benefit to the public or are necessary in the public interest; or are contributing to the development of the art.
5. That in time of war or other national emergency the President shall have the power to discontinue or commandeer existing stations with just compensation.
6. That no monopoly in radio broadcasting shall be permitted.
7. That the legislation shall contain provisions for due appeal from final decisions of the Secretary of Commerce to the appropriate court.

CALL LETTERS A PROPERTY RIGHT

8. Except in the case of governmental stations the Secretary shall be empowered to classify all stations and to affix and assign call letters, wave-length, power, location, time of operation, character of emission and duration of licenses. It is recommended that call letters shall be recognized as representing a property right and be treated accordingly during the life of the license. The Secretary shall not change call letters, wave-length, power, time of operation nor character of emission except on the application by or consent of the licensee; provided, however, that if in the opinion of the Secretary such changes are required as a public necessity any change or changes may be made.

   Provided, further, that the term of a license to operate a broadcasting transmitting station, the character of which is to be defined in the act, shall be not to exceed five years, with the privilege of renewal for like periods, and provided, further, that the Secretary may suspend or revoke any license for failure to maintain a regular operation of a transmitting station without just cause.
9. No license shall be issued to operate a transmitting station not already operating in radio communication, except mobile or amateur stations, unless prior to the application for such license there shall have been issued by the Secretary of Commerce an erection permit; provided, further, that an erection permit to engage in radio communication shall be issued only to those who, in the opinion of the Secretary of Commerce, will render a benefit to the public; or are necessary to the public interest; or are contributing to the development of the art.

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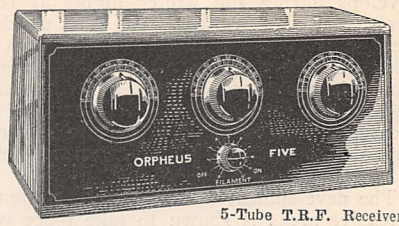

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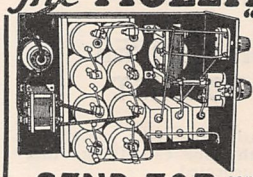

SEND FOR complete description of this powerful "B" Unit that you can build in an hour at most reasonable cost. Uses the current from the light socket—Excellent for Supers and all TRF Sets—Assures greater Clarity—DX and Volume — Noiseless — No Tubes nor Acids—Utilizes full wave rectification.

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10. Each license to operate a transmitting station in radio communication shall prescribe the responsibility of such station with respect to distress signals; but in any event all licenses shall provide that upon due and proper order from governmental authority such stations shall cease operation until released by the same authority.
11. That the act should define the following terms, to wit: Commercial stations, broadcasting stations, amateur stations and experimental stations.

POWER TO REVOKE LICENSES

12. That the Secretary shall have the power to revoke or suspend any license whenever he shall determine that the licensee has violated any of the terms of his license, regulation of the Secretary, Federal radio law or international treaty.
13. That in order to insure financial stability to radio enterprises, capital now invested must receive reasonable protection. Therefore all stations which contribute to the public interest and benefit shall be given a reasonable length of time to conform to the provisions of the proposed act and the rules and regulations prescribed thereunder.
14. That rebroadcasting of programs shall be prohibited, except with the permission of the originating station.
15. That the Secretary of Commerce shall be empowered to make and enforce such rules and regulations as may be necessary to prevent interference to radio reception emanating from radio sources.
16. That authority should be provided to prescribe and enforce uniform regulations regarding the use of radio transmitters on ships in territorial waters.

PUT COPYRIGHT UP TO CONGRESS

The Committee on Copyrights, of which Representative Wallace H. White of Maine was Chairman, wrestled with the problem for three days in an effort to compose the differences between representatives of the American Society of Authors, Composers and Publishers, and the broadcasters. It was agreed by the broadcasters who appeared before the committee that the owners of copyrights were entitled to reasonable compensation for the use of their productions. The parties to the dispute were unable to agree, however, upon the terms and conditions of use of copyrights. The committee, therefore, refrained from making any recommendations but presented resolutions outlining principles which in its opinion should control in a solution of the problem by Congress. The resolution related only to musical compositions.

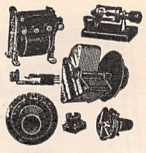
The committee on General Allocation of Frequency of Wave-Lengths decided against any substantial changes in the allocation of wave-lengths out of consideration for the amateur.

The Committee on Marine Problems recommended reciprocal arrangements with other Governments looking toward the prohibition of the use of frequencies between 1,500-550 kc/s (200-545 meters) by vessels of such countries when within 250 miles of the American coast and that the frequency band between 400-350 kc/s (750-850 meters) be not used by any nation within 500 miles of a radio compass station of the United States except for compass work.

The Committee on Amateur Matters recommended that the Department of Commerce shall no longer license the use of spark transmitters on amateur bands; that amateur telephone operation be permitted in the amateur band between 3,500 and 3,600 kc/s (83.3 to 85.6 meters), provided such stations observe the prescribed amateur silent hours.

The Committee on Interference recommended that the elimination of interference from radiating receivers already in use should preferably take the form of persuasion rather than coercion, and that in view of present air congestion the Secretary of Commerce under certain limits should withhold further licensing of stations.

—Abstract, The New York Times.



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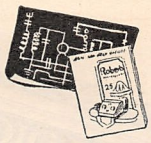

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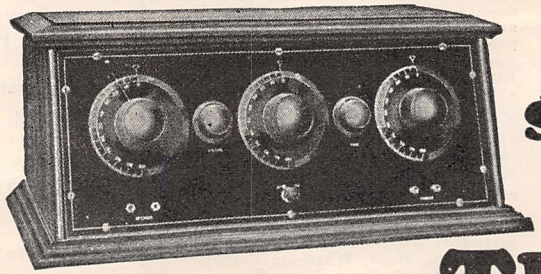

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MOTOR CAMPER & TOURIST, printed entirely in rotogravure, is the only national motor touring magazine. In every issue there are special departments giving latest information on Routes, Maps, Where to Camp or Stop, Vehicle Laws, Motor Camping Cars and Accessories, Care of the Motor, Roadside Repairs, Camp Cookery, etc.

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Correspondence from Readers

(*Continued from page* 996)

a detector crystal. I doubt if this observation will have any practical value; but it may possess theoretical significance in the fact that a liquid metal has the property of functioning as a detector. This may open the way to new discoveries in the cause of the detector properties of certain crystals, about which very little seems to be known. Being much occupied in my own special field (rubber chemistry), I am not in a position to follow up this observation with a thorough study. I am, therefore, simply stating what I have seen, leaving it to radio experts to make further study and find practical applications, if any exist. I ask only that a copy of any publications arising from such studies be sent to me.

Since there is a broadcast station in Graz, I have been able to pick up the Graz and Vienna stations on my small, cheap "Baby Vocaphone." This little set operates from the electric light circuit. I took out the crystal and put in mercury instead. With a very fine spirally wound wire for contact, I was able to hear very clearly, though the sound was fainter than with the crystal. There was a great difference, however, in results with contacts at different points on the mercury surface. Good reception was only obtainable at certain points, exactly as is the case with a crystal. This I believe to be the most important feature of my discovery. It may furnish the starting point for a theoretical explanation of the phenomenon.

I may add that I have tried a whole series of mercury amalgams, but without success in every case.

RUDOLF DITMAR,
Graz, Austria.

Amateur Radio Organization

(*Continued from page* 993)

more effective this fight would have been if there had been present not three or four, but a dozen, or twenty men, each a delegate from his section or division, and truly representing the viewpoint of the amateurs who sent him!

District councils, and councils alone would be able to secure the amount of money to finance country-wide representation at national and international meetings, where the amateur should and needs to be represented.

This "council" idea is not new. It has been, in fact, greatly developed by very capable minds indeed. The facts that there are executive radio councils in the first, second, third, and eighth districts shows that the council idea is sound. Some of these bodies have been functioning for over five years, governing their own sections, putting on an annual amateur convention, publishing local journals, or "sheets," and generally contributing much to amateur radio.

These councils are in many cases receiving little co-operation from some narrow-minded amateurs who are doing everything to stop the growth and influence of these bodies. Some of the foulest means have been taken to dismember and discourage the efforts of the councilmen.

The council idea will grow. Actually, we need councils, and the sooner we get under way, and organize ourselves strongly, positively and permanently, the more secure we will be in the years to come.

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RADIO—BARGAINS

A MESSAGE TO RADIO NEWS READERS

This message is directed to thousands of our friends who are looking forward to the page bargain announcements we carried in these columns last year. Because the growth of radio has been so rapid, we find that it would take an entire issue of RADIO NEWS to list the many bargains in radio that Barawik has to offer this season. For this reason we have discontinued them and in their place have compiled the Barawik Catalog and Guide in which is shown thousands of bargains such as the radio world has never known before. We have gathered together the greatest collection of radio sets, kits and parts ever assembled by any institution and these are fully illustrated, described and priced at tremendous savings in the new BARAWIK BARGAIN BOOK.

Free Copy to Radio News Readers

Every reader of Radio News is entitled to this book free and we have reserved a supply for just this purpose. Free copy will gladly be sent you upon request. Simply send us your name and address and your copy will be mailed at once. (Please include names of other radio fans to whom we can send free copy also.)

Don't spend a penny for anything in radio before you see this catalog. It will be a happy surprise for you. Send letter or postal today—NOW—and you will be money ahead.

The Barawik Co.
102-142 So. Canal St., Chicago, U. S. A.

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Bankrupt and Rummage Sales. Make $50.00 daily. We start you, furnishing everything. Distributors, Dept. 213, 509 Division, Chicago.

Sell Lawlite Deflector Shields to motorists, garages, etc. Makes any headlight legal: 100 per cent. profit collected as sold. Get details immediately. Lawlite Company, Dept. K, 396 Greenwich Street, New York City.

Agents Wanted to Advertise our goods and distribute samples given to consumers; 90c an hour; write for full particulars. American Products Co., 5797 American Bldg., Cincinnati, Ohio.

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Boys—Get a three-foot model aeroplane free. Write to Aero Shop, 3050 Hurlbut Ave., Detroit, Mich.

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Free Book. Start little Mail Order Business. Pier, 996 Cortland Street, N. Y.

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$50 a week. Mail Order business. Booklet tells how. Sample and plan 25c. Outfit furnished you Free. Bradford Co., Dept. E, Shawnee, Okla.

Chemistry

Learn Chemistry at Home. Dr. T. O'Conor Sloane, noted educator and scientific authority, will teach you. Our home study correspondence course fits you to take a position as chemist. See our full page ad on page 1055 of this issue. Chemical Institute of New York, 66 W. Broadway, New York City.

Educational

Used Correspondence School courses save over half. Bargain Catalogue 1000 courses free. Used courses bought. Students' Exchange, Dept. A, 47 West 42d St., New York.

Exchange

200-20,000 meter Receiver Radiotron $25.00. Smith, 4416 Market, Philadelphia.

Farms and Orchards

Pecan-Orange-Fig Groves "On the Gulf." Guaranteed care. Monthly payments. Big quick returns. Suburban Orchards, Dept. R, Biloxi, Miss.

For Advertisers

24 Words—355 Rural Weeklies $14.20. Admeyer, 4112-R Hartford, St. Louis.

Help Wanted

All men-women, 18-65, wanting to qualify for Government Positions, $140-$300 monthly, write Mr. Ozment, 251, St. Louis, Mo., immediately.

Detectives Needed Everywhere. Travel. Experience unnecessary. Write, George Wagner, former Government Detective, 1968 Broadway, N. Y.

Help Wanted (Continued)

Firemen, Brakemen, Baggagemen, Sleeping car, train porters (colored), $140-$200. Experience unnecessary. 237 Railway Bureau, East St. Louis, Ill.

Detectives needed everywhere; large salaries; free particulars; write National Headquarters, 188 East 79th, New York.

Incorporations

Delaware Incorporator, Charters; Fees Small; forms. Chas. G. Guyer, 901 Orange St., Wilmington, Del.

Insects Wanted

Why not spend Spring, Summer and Fall gathering butterflies, insects? I buy hundreds of kinds for collections. Some worth $1 to $7 each. Simple outdoor work with my instructions, pictures, price-list. Send 10 cents (not stamps) for my illustrated Prospectus before sending butterflies. Mr. Sinclair, Dealer in Insects, Box 1424, Dept. 40, San Diego, California.

Instruction

Learn Chemistry at Home. Dr. T. O'Conor Sloane noted educator and scientific authority, will teach you. Our home study correspondence course fits you to take a position as chemist. See our full page ad on page 1055 of this issue. Chemical Institute of New York, 66 W. Broadway, New York City.

Miscellaneous

Skinderviken Transmitter Button. Free tested hook-ups. Loud Speakers. Experiments. K Electric Co., 2 Rector Street, New York City.

Motion Pictures

Films for Toy Machines. Hart—Mix-Chaplin. Complete stories 1000 feet $3.50. Special 200 foot lengths $1.50 postpaid. Big Boys list Free. Monarch Films, Department 3, Memphis, Tenn.

Motorcycles, Bicycles

Don't Buy a Bicycle Motor Attachment until you get our catalog and prices. Shaw Mfg. Co., Dept. 6, Galesburg, Kansas.

Novelties

Magic goods, cards, books, novelties, tricks. Catalog free. B. Fenner, 2401 Jefferson, Louisville, Ky.

Old Coins

German Gov't Bond 5,000,000 Mk, 1924, $1.50. 2,000,000 Mk Bond 1923, $5.00. 500,000 Mk. Bill and Catalogue, 10c. Norman Shultz, Colorado Springs, Colo.

Old Money Wanted

$2 to $500 each paid for hundreds of Old or Odd Coins. Keep all old money, it may be very valuable. Send 10c for New Illustrated Coin Value Book, 4x6. Guaranteed prices. Get posted. We pay Cash. Clarke Coin Company, 14 Street, LeRoy, N. Y.

Patent Attorneys

Inventors—Should write for our Free Guide Books and "Record of Invention Blank" before disclosing inventions. Send model or sketch of your invention for our Free Inspection and Instructions. Radio, Electrical, Chemical, Mechanical and Trademark experts. Terms reasonable. Victor J. Evans & Co., 922 Ninth, Washington, D. C.

Patents. Send drawing or model for examination and report as to patentability. Advice and booklet free. Highest references. Best results. Promptness assured. Watson E. Coleman, Patent Lawyer, 644 G Street, N. W., Washington, D. C.

Patents—My fee in installments. Free personal advice. Frank T. Fuller, Washington, D. C.

Patents—Send for form "Evidence of Conception" to be signed and witnessed. Form, fee schedule, information free. Lancaster and Allwine, Registered Patent Attorneys in United States and Canada, 269 Ouray Bldg., Washington, D. C.

Patent Attorneys (Continued)

Inventors—who derive largest profits know and heed certain simple but vital facts before applying for patents. Our book Patent-Sense gives those facts; free. Write Lacey & Lacey, 631 F St., Washington, D. C. Established 1869.

Patents

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Lonesome—Join our club—make acquaintances everywhere. Big illustrated book with descriptions and photos, sent in plain wrapper for ten cents. Bonafide Co., Dept. 58, Kansas City, Mo.

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Radio

Boys! Don't Overlook This. The "Rasco" Baby Detector. Greatest detector ever brought out with molded base. Fully adjustable. See former advertisements in this publication, or our catalog. Detector with Galena Crystal, complete 50c, the same detector with Radiocite Crystal, 75c prepaid. Send for yours today. Radio Specialty Company, 96-98 Park Place, New York City.

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Make Your "B" with Edison Elements. They last a lifetime. Pair 5 cents; welded, 7½ cents postpaid. Henry Chapelle, Woodburn, Ore.

Supersensitive Galena Crystals, pound $1.00, prepaid. Alkemite, All-sensitive Crystals, 50c. Buskett, Joplin, Mo.

Radio Fans wanted to sell standard radio apparatus. H. A. Roberts & Co., 180A Broadway, New York City.

Radio Supplies. Send for free Catalogue. Robert E. Bedford, Johnstown, N. Y.

Save on your radios by purchasing guaranteed parts. Lists on request. Box 390, Danville, Ill.

For Sale—5000 Pair Edison Elements; want offer. Cooperative Merchandise Company, Chelsea, Massachusetts.

Radio Tables, Walnut Veneer Tops, 17"x32", shelf for batteries, special price $10.00. Kane Cabinet Company, Kane, Pa.

Edison Elements, large size, Electrically Welded, Pair 7 cents. Complete Hook-Up and sample Pair 20 cents. Martin Company, 1841 West Van Buren Street, Chicago, Ill.

Our prices are a revelation. Send for our big Radio Bargain list for proof. E. Parker, Putnam St., Peabody, Mass.

Universal Plio-6. Tunes 35 to 3600 meters. Ultradyne, All-American Sets and Kits, New Radiotron, Power Tubes. Literature Free. Ray Radio Supply, Sandusky, Ohio.

Marvelous Radio Hookup Free. With our simple plans you can build a radio like the one picked by us as the best regenerative hookup known. Send stamped, addressed envelope for free diagram. Songbird Transformer Works, Dept. C, 1507 West 58th Street, Chicago.

Get Distance!! My famous one-tube super-selective—super-DX hook-up and data—50c. A. C. Thurman, R. R. 1, Box 331F, Oakland, Calif.

Slightly Used Western Electric Microphones $1. VT2's $5. RCA variable transmitting condensers $1.50. 3-coil bakelite geared mountings $1.50. 30v input 300v output transmitting generators $8. Large stock, postage extra. Will buy surplus transmitting parts and AC 3500 speed ¼ hp. motors. R. Wood, 38 Wave Ave., Corona, New York.

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Want to hear from owner of farm, city property or store for sale. Send description. Real Estate Salesman, 543 Brownell, Lincoln, Nebr.

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A Salesman wanted in every town or city within 25 miles of a broadcasting station to sell Radiogem, the complete radio receiving set that retails for $2.50. With Radiogem there is nothing else to buy—the outfit includes the Radiogem receiving apparatus, 1,000 ohm phone, and aerial outfit. The cheapest radio outfit on the market—yet as practical as the most expensive. Big money to the right men. Send $2.00 for sample outfit. The Radiogem Corp., 66-R West Broadway, New York City.

Make $100 Weekly in spare time. Sell what the public wants—long distance radio receiving sets. Two sales weekly pays $100 profit. No big investment, no canvassing. Sharpe of Colorado made $955 in one month. Representatives wanted at once. This plan is sweeping the country—write today before your county is gone. Ozarka, Inc., 130-H, Austin Ave., Chicago.

Salesmen calling on radio trade for profitable, non-competitive accessory. Address Rovim Co., 318 Friendship, Providence, R. I.

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Settings for Opera, Plays, Minstrels. Plush Drops. Address Amelia Grain, Philadelphia.

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Songwriters: Let me furnish the music for your songs, guaranteeing you absolute satisfaction. Copyrights secured. Submit your scripts for estimate and free advice. Walter W. Newcomer, 1674 Broadway, New York.

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Telegraphy—Both Morse and Wireless taught thoroughly. Big salaries. Wonderful opportunities. Expenses low; chance to earn part. School established fifty years. Catalog free. Dodge's Institute, Cour St., Valparaiso, Ind.

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Full Value Paid for Old Gold, Jewelry, Watches, Diamonds, crowns, bridges, dental gold, silver, platinum, gold or silver ore; magneto points, old false teeth. Packages returned if our offer is not satisfactory. United States Smelting Works (The Old Reliable) 39 So. State St., Dept. 16, Chicago, Ill.

To the Live Radio Dealer

Are you tying up with the manufacturer of the sets and parts that you handle by selling to your customers The GREATEST RADIO Magazine that contains his advertisement?

Sell Radio News
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NEWSSTAND DEPT. 12
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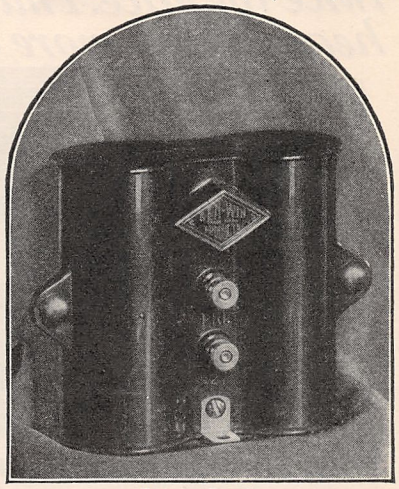

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To get all that any set can give, you must use this greatest scientific advancement of all — GEN-WIN Lemnis-Coils. They give astonishingly better results because they are the only inductances offering you *all* these advantages:

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3—*Lemnis-Coils* amplify only what is received from the preceding stage. Their non-pick-up qualities reduce the annoyance of static and other interference.

4—*Lemnis-Coils* are kept free from dust by means of sealed Bakelite cases, thus retaining their full efficiency.

5—*Lemnis-Coils* used to replace any type of tuned radio frequency transformers or antenna couplers, will increase the sensitivity and selectivity of your receiver.

GENERAL WINDING CO., INC.,
214 Fulton Street New York, N. Y.

SEND THIS COUPON IF DEALER HAS NO LEMNIS-COILS

GENERAL WINDING CO., INC.,
214 Fulton Street, New York, N. Y.

You may send me one guaranteed Kit of three GEN-WIN Lemnis-Coils, complete with blue-print, showing detail of hook-up.

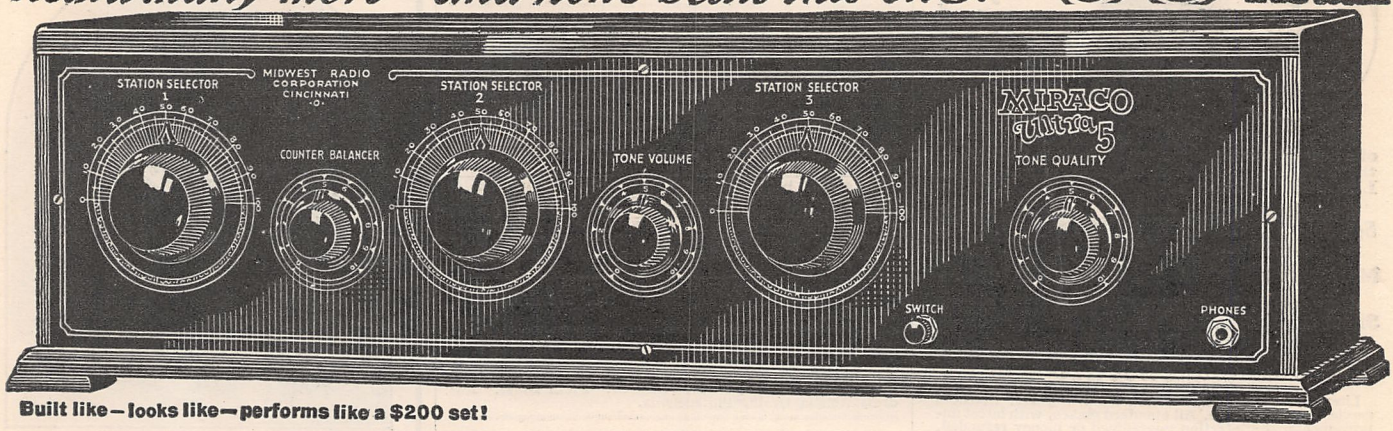
☐ Enclosed is money-order for $12. (Ship postpaid.)
☐ Send C. O. D. (I will pay postman $12 plus postage.)

It is understood that these coils are guaranteed to afford the utmost in radio reception.

Name .....
Street and No. .....
City ..... *State* .....

Now only $59.50 Retail

"It works better than a lot of sets that sell for twice the price. I have owned four other sets and heard many more - and none beats this one."



Built like—looks like—performs like a $200 set!

Demand Breaking All Records—More User-Agents Needed—Get Wholesale Prices Quick

MIRACO RADIO GETS 'EM COAST TO COAST

Notice!

Enormous demand for the celebrated Miraco Ultra 5 (resulting from its many enthusiastic users so highly recommending it to their friends) enabled us to add hosts of costly new features, latest refinements and up-to-the-minute improvements such as you might expect to find only on the newest sets selling at much higher prices. So the Improved Ultra 5 for 1926 is even a better set—a more beautiful set—a more selective and more powerful set—incredible as this may sound! —for less money than ever before.

COAST TO COAST RECEPTION VERIFIED BY USERS

Reports from Ultra-5 users everywhere leave little for us to add. These are only a few of the many in our files and which we receive daily. Send coupon for plenty of additional proof. Let testimony of users instead of high-sounding claims convince you.

MANY SAY IT'S BEST THEY'VE HEARD

"Ultra 5" more than meets my expectations of a good radio set. Many think it is the best that they have heard. For volume, selectivity, clearness and long distance it is unsurpassed in my estimation . . . . . Auto Supply, Allentown, Penna.

PRAISES THE FINE TONE AND VOLUME

The Ultra-5 has a fine tone and good volume; last night had 24 different stations from 8 to 10—all on loud speaker, O. T. . . . . Malone, New York.

THE TONE IS "WONDERFULLY CLEAR AND POWERFUL"

Am more than pleased with my 5 tube Miraco. Tone wonderfully clear and powerful. D. C. . . . . Detroit, Michigan.

MORE PRAISE FOR MIRACO TONE QUALITY

The Ultra-5 received from you is the best I ever heard. It is just as clear as a crystal. Raymond W. . . . . Massback, Ill.

ONE OF THE CLEAREST EVER HEARD

All who have heard my Ultra-5 set pronounce it one of the clearest they have heard, and I must say that the MIRACO is in every way as represented by you. George . . . . . Colville, Washington.

MONTANA HEARS BOTH COASTS

Ultra-5 set is O. K. Have got them, New York to Los Angeles, Winnipeg to Dallas, Texas. W. H. . . . . Polson, Montana.

OHIO GETS 'EM COAST TO COAST

We are enjoying the Ultra-5 Radio. It is all you recommended. We get stations on the east coast, south and west coast, Walter . . . . . Van Buren, Ohio.

CALIFORNIA THE FIRST NIGHT

Headphones are not necessary with the Ultra-5. I had KFI, California, the first night with same volume as Pittsburgh. Fred G. . . . . Liverpool, Ohio.

COAST TO COAST FROM OKLAHOMA

With Miraco five tube set am getting stations on the Pacific and Atlantic coasts. Yerker E. . . . . Pauls Valley, Okla.

"COAST TO COAST" A REALITY

The two Miraco-5's have been working fine, in fact far beyond our expectations. Your statement of "coast to coast" reception proved absolutely a reality. T. D. . . . . Houston, Texas.

MICHIGAN GETS COAST TO COAST

I am overly pleased with the Miraco Ultra-5. Can get stations from coast to coast and from Texas to Canada. Geo. O'. . . . . Gordon, Michigan.

LOTS OF VOLUME—20 STATIONS FIRST NIGHT

Will drop you a few lines to let you know that I received my Miraco Ultra-5 and that it works fine. Had 20 stations the first night—it has lots of volume. Fred . . . . , Versailles, Ill.

INDIANA HEARS BOTH COASTS

Miraco Ultra-5 is a first-class set in every respect. It can't possibly be beat for the price. The first night I received over twenty stations from both coasts. Adolph M. . . . . Indianapolis, Indiana,

MINNESOTA HEARS COAST TO COAST

Received Ultra-5 in fine condition. Have received programs from stations all over the United States and Canada. We find it is one of the best sets in this locality. We are well pleased with the wonderful results. Clarence . . . . Nashwauk, Minn.

HEARS CALIFORNIA TO EUROPE

Enclosed is a partial list of the stations I received with the Miraco Ultra-5: KSD, WEBH, WBAV, WEAF, WLW, WCHD, WHB, WOR, WJAZ, WOC, WHAS, WWJ, GKAC, KFIX, WCK, WHAZ, KFAB, WHAA, WASI, WCAP, WTAS, WQJ, KFKX, WAAW, WTAM, WOAI, WSOE, WCCO, KDKA, WBAP, WMC, CNRO, WLS, WHJ, WBZ, WNH, KFNF, KFI, WEEI, WWL, WFAA, WAF, WGY, CKY, WRR, WCAE, WEAO, WRC, FFDM, WJJD, WGR, WABN, WCAL, WLB, WHN, WMAQ, WJZ, WLS, WOAW, WOO, WOS, CFAC, Sheffield (Eng.), Paris (France). Carl H. . . . . Waukesha, Wis.

MONTANA HEARS CALIFORNIA TO IRELAND

I am more than pleased with the Ultra-5 Receiver. I have 90 stations on my record in 20 days' time, including KDKA, WCAL, KFLE, WFC, WCC, WIAM, WEAF, WEM, WGM, WCAL, WLW, CAM, CFCF, WJJ, WAE, KAKF, KOOW, WCCO, WOC, WCAZ, WHO, WCCA, WOAW, CFAC, WOAI, WOS, WCKF, KFPU, KBB, KPO, KFAA, WMCR, CKY, WCCP, WMAW, WHAP, WGN, KJR, WHJ, WOS, WMC, WJJ, WGAN, KKU, WGW, WLW, WOOI, WHB, WFAI, WJAZ, KGB, WCAF, KSAC, WTAP, KSKI, KFKA. On February 16th at 12:15 o'clock I received Ireland, the distance being several thousand miles. Richard . . . . Comertown, Mont,

WEST VIRGINIA HEARS AUSTRALIA

Got 2-XB Wellington, Australia, plain last night at 12:45 A.M. over the Ultra-5 Miraco you sold me. I am delighted and would not trade for any instrument in town. Geo. . . . . Glen Ferris, West Va.

ALL WE CLAIM . . . AND MORE.

Miraco Ultra "5" Set installed yesterday evening—had wonderful results last night. Think Ultra "5" is all you claim and more. V. A. . . . . Hampshire, Tennessee.

The reports we print are from UNSOLICITED letters sent us by pleased users.

The Powerful New MIRACO Ultra 5

Guaranteed by One of the Oldest Radio Builders

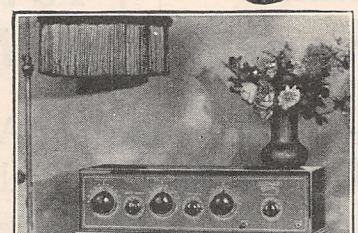
Tested and Approved by Radio's Highest Authorities

[ULTRA SELECTIVE FIVE TUBE SET IN MAHOGANY CABINET]

You can either *save* or *make* a lot of money on sets and supplies by sending coupon today for our *Amazing Special Offer!* It will astonish you. Big profits easy—accepting orders for Miraco Sets. Only necessary to order one set to demonstrate in your home. No agreements to sign—no salesmanship required. The performance of Miraco Sets does the selling. Greatest demand in the six years we have been building sets—we need more user-agents to supply it.

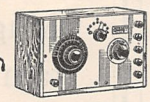
This latest improved 1926 model Miraco Ultra 5—completely built, thoroughly tested and factory guaranteed by the Midwest Radio Corporation, one of America's oldest, reliable and most successful makers of quality sets—is an astonishing bargain in the opinion of radio experts. Selectivity, long distance reception, clarity of tone, power and volume have been amazingly increased—"B" battery consumption is minimized—oscillations are easily controlled on all wavelengths, through use of latest radio inventions. Among these are: "Duoformers" (ultra low-loss inductance coils); the "Counter-Balancer" (patented); flexible wiring which prevents broken or noisy connections; an adjustment for different length aerials; use of only two rheostats; a cut-out switch; concealed wiring under genuine Formica baseboard and other features of costliest sets.

Literature describes them fully. Send for it—and Special Offer that will surprise and interest you.

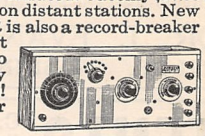


The improved new Miraco Ultra-5 is a beauty! Handsomely gold-etched genuine Formica panel and large Bakelite knobs with "arrow point" indicators (for fine tuning) add to the stylish appearance. Mahogany cabinet is hand rubbed. A radio you will be proud to have your friends see and proud to have them hear perform.

Other Miraco Long Distance Sets $13.75 up retail



Wonderfully improved new models in one-tube and three-tube Miraco Long Distance Sets also ready at lower prices! New Miraco R-3 at only $27.35 (retail) operates loud speaker on distant stations. New one-tube Model R is also a record-breaker for distance at $13.75. All Miraco sets work on storage or dry batteries, are easily connected and operated. Unmatched values! Let testimony of users convince you. Write for literature and Special Offer—use coupon.



AGENTS! DEALERS! Write for the new Miraco proposition. Nation-wide use and popularity of Miraco sets, coupled with their amazingly low prices make them wanted everywhere.

Get Special Offer!

All the Proof you want is waiting for You!

Reports from hosts of users in every state prove Miraco sets—at rock-bottom factory prices—outperform sets costing up to three times as much. Send for latest literature, SPECIAL OFFER and plenty of additional testimony leaving no doubt that "Miraco Radio Gets 'em Coast to Coast."

MIRACO RADIO GETS 'EM COAST TO COAST

Send coupon for Amazing Special Offer!

MIDWEST RADIO CORPORATION
Pioneer Builders of Sets
Cincinnati, Ohio

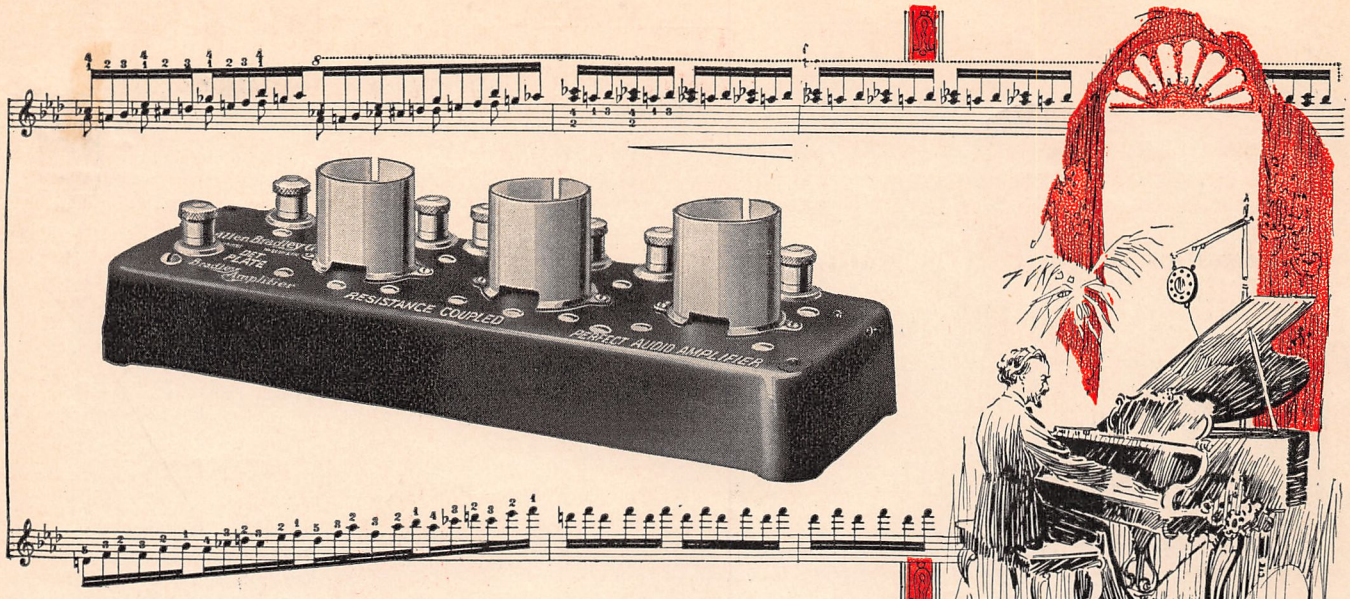
404-N East Eighth Street

Send free literature, AMAZING SPECIAL OFFER and all particulars regarding your big money-saving proposition on Guaranteed Miraco Sets and all radio supplies.
[] Agent [] User [] Dealer.

NAME.....

ADDRESS.....

PRINTED BY GILES PRINTING CO, LONG ISLAND CITY



Hear ALL the Music

with the Bradley-Amplifier

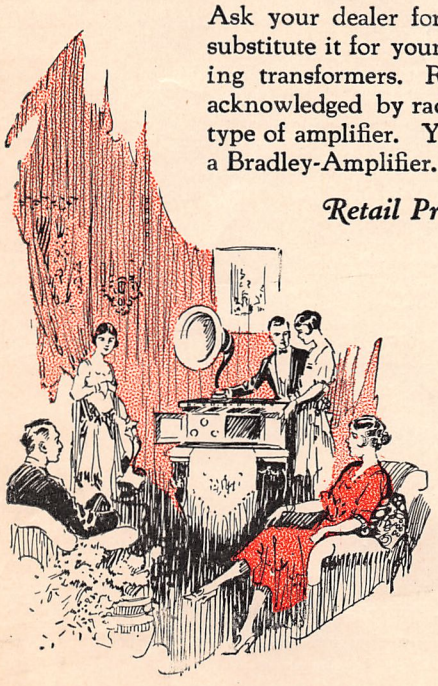
THE delicate variations and shadings of instrumental music and the exquisite strains of the vocalist are amplified with faithfulness and clarity by the Bradley-Amplifier. It matters not whether you own a factory-built set or a home-built receiver, either will be improved by using the Bradley-Amplifier.

Bradleyunit resistors, that are impervious to moisture and unaffected by atmospheric changes, take the place of the audio-frequency transformers of ordinary amplifiers. There is no distortion and no loss of low or high frequencies. All tones are reproduced with equal facility.

Ask your dealer for the Bradley-Amplifier today and substitute it for your present audio-frequency amplifying transformers. Resistance coupled amplifiers are acknowledged by radio experts to be the most perfect type of amplifier. You can make your set perfect with a Bradley-Amplifier.

Retail Prices—In U. S. A. $15

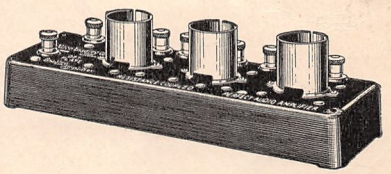
—In Canada $21



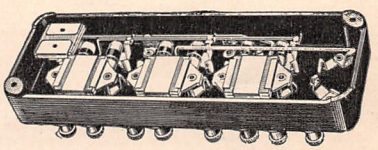
Allen-Bradley Co.

Electric Controlling Apparatus

MILWAUKEE, WISCONSIN



Can be installed within radio cabinet. UX as well as old tubes can be used.



All resistors, condensers, and wiring, are concealed within Bakelite base.

Bradleyunit resistor is made of solid molded material which does not change with age. All units are soldered.

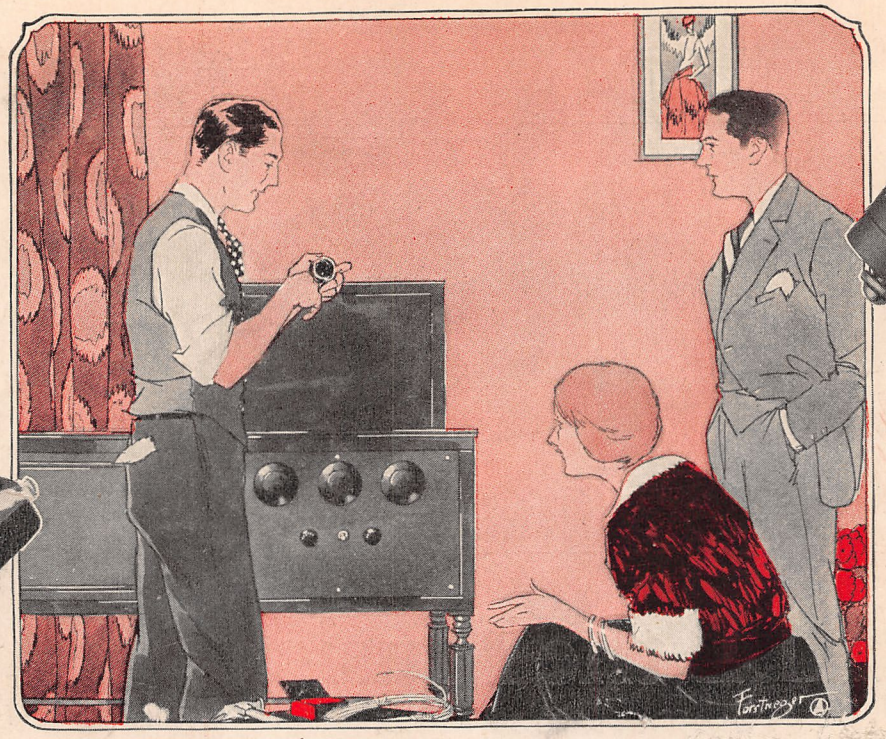
ALLEN-BRADLEY CO.
287 Greenfield Ave., Milwaukee, Wisconsin
Please send me your latest literature on the Bradley-Amplifier, explaining how it will improve my receiver.

Name .....

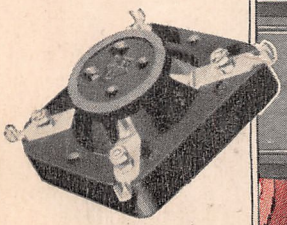
Address .....

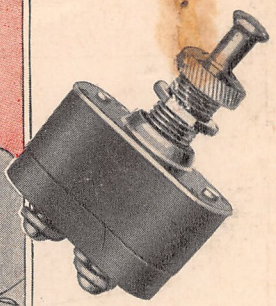
.....

Mail the Coupon



The new C-H Socket for the UX tubes. Same one piece, double-grip, SILVER plated contacts used in the standard C-H Socket with the ORANGE shell. Heatproof Thermoplax base. Genuine low-loss construction and attractive appearance.





The original radio switch —with the long life mechanism outlasts the set. Easy to mount, only one hole needed, and adjustable to all panel thickness. Can also be used in new batteryless sets.

In Radio especially—
"it's the little things that count"

A list of some of the prominent radio manufacturers using C-H products

Acme Apparatus Co.
American Bosch Magneto Co.
Astral Radio Corporation
Boissier Radio Corporation
Chelsea Radio Co.
Crosley Radio Corporation
Dayton Fan & Motor Co.
Dictagraph Products Co.
Dubilier Condenser & Radio Corporation
Electrad, Inc.
Freed-Eisemann Radio Corp.
Garod Corporation
Gilfillan Bros., Inc.
Allen T. Hamscomb
Harding Mfg. Co.
Howard Radio Co.
The Keyport Laboratories
King Electric Mfg. Co.
Kodel Radio Corporation
LeMor Radio, Inc.
Magnus Electric & Radio Co.
Malone-Lemmon Laboratories
Glenn L. Martin Co.
Wm. J. Murdock
Newport Radio Co.
Phanstiehl Mfg. Co.
Philadelphia Storage Bat. Co.
Radio Master Corp. of America
The Radio Compak Co.
R. B. Radio Co.
Robbins Radio Co.
Signal Electric Co.
Silver-Marshall Co.
Simplex Radio Co.
R. E. Thompson Co., Inc.
J. S. Timmons
Workrite Mfg. Co.
Zenith Radio Co.

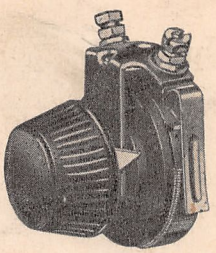
WHEN your radio set goes wrong, just as you are comfortably settled before the fireplace expecting to spend a great evening, it *is* annoying.

And ten to one, it's only some little wire or part that in itself is insignificant. Really, though, there's no excuse for such things happening.

GOOD parts of good material and carefully built are insurance against such annoyances.

Cutler-Hammer radio parts are GOOD parts. Both the amateur builder and the set manufacturer can attest that fact. They are designed by radio control experts, backed by 25 years experience, built of the highest quality material and sold at a price you are glad to pay.

Whether you buy or build, insist on C-H radio parts, for it's these good little parts that count and assure constant, efficient service from your set.



The closely wound, fine resistance wire is prevented from slipping or wearing out of true by a bronze spring. Thus smooth, quiet control is assured either advancing or decreasing the potential.

There is no jumping, no back lash; and no sticking.

While C-H Rheostats are built to engineers' specifications, they are designed for the use of the novice. They are built as a unit and are not dismantled for mounting.

Only one hole for mounting. Self centering in oversize holes and adjustable to any panel thickness.

THE CUTLER-HAMMER MFG. COMPANY

Member Radio Section, Associated Manufacturers of Electrical Supplies

MILWAUKEE, WISCONSIN

CUTLER-HAMMER

Radio Parts for Performance